A Scranton Gillette Publication

APRIL 1961

WATER & SEWAGE WORKS

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ANN ARBOR, MICH.
COMP

WATER SUPPLY • SEWAGE DISPOSAL

EPOXY-VINYL
used to repaint
Sedimentation Basin.
Connellsville, Pa.

p. 138

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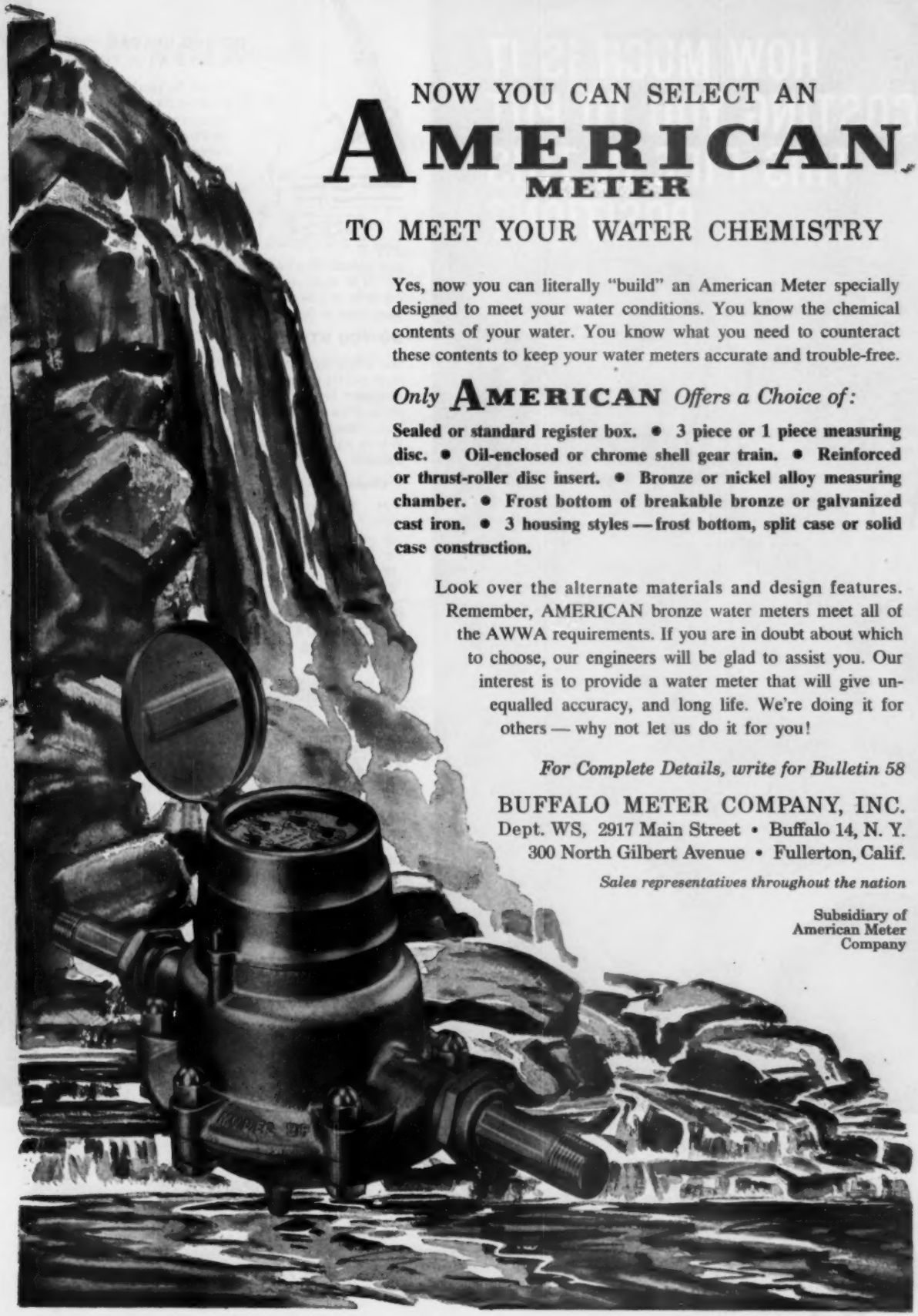

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AMERICAN METER

TO MEET YOUR WATER CHEMISTRY

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Look over the alternate materials and design features. Remember, AMERICAN bronze water meters meet all of the AWWA requirements. If you are in doubt about which to choose, our engineers will be glad to assist you. Our interest is to provide a water meter that will give unequalled accuracy, and long life. We're doing it for others — why not let us do it for you!

For Complete Details, write for Bulletin 58

BUFFALO METER COMPANY, INC.
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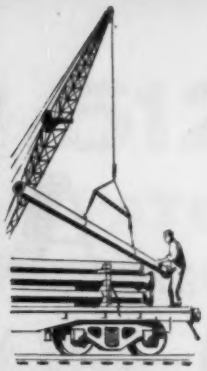
Subsidiary of
American Meter
Company

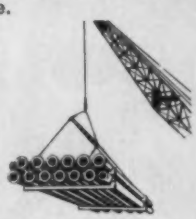
HOW MUCH IS IT COSTING YOU TO PUT THIS PIPE IN THIS POSITION?



DO YOU UNLOAD PIPE 1, 2, OR 3 AT A TIME?

If you do you'll find unloading *flat cars* easier, more economical than unloading from a gondola. Perhaps you already have the crane capacity to save even more man hours by using standard pallets especially designed for *Griffin-20** pipe. With a fork-lift, or a crane, you can unload 96 pipes in *four* or *eight* lifts. (One flat car of 6" pipe, or four double-pallets.) Or, if your crane is in use elsewhere, "skid" pipe directly to your truck or to your stockpile.

DO YOU STOCKPILE?



Our single-layer and double-layer pallets are specifically designed for multiple handling. Pipe remains palletized, ready for re-loading. Which pallet can your lift handle?

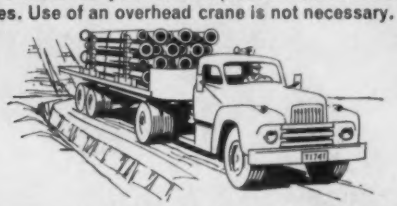
Single-Layer Pallets			Double-Layer Pallets		
Size	Pieces	Weight	Size	Pieces	Weight
4"	16	2½ tons	4"	32	5 tons
6"	12	3¼ tons	6"	24	6½ tons
8"	9	3¾ tons	8"	18	7¼ tons
10"	7	3¾ tons	10"	14	6½ tons
12"	6	3¾ tons	12"	12	7¾ tons

IF YOU STOCKPILE YOUR PIPE, WHAT IS YOUR COST FOR RE-LOADING IT AND TAKING IT TO YOUR JOB-SITE?

Pallets are designed for *quick* re-loading on trucks or flat-beds for installation-site delivery. You reap the benefits of a *double saving* in man-hours, since you save as much in re-loading as you do in unloading!

CAN YOU USE PIPE TRUCK-DELIVERED TO YOUR JOB-SITE?

All trucks for *Griffin-20* pipe are equipped with ropes and skids for easy trench-side placement of individual pipes. Use of an overhead crane is not necessary.



Remember...Ultimate cost is not what you pay for pipe, but how much it costs you to deposit it alongside trench.

*Griffin-20 trademark is the property of Griffin Wheel Company.

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WATER & SEWAGE WORKS

VOL. 108 NO. 4

APRIL 1961

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Note:

Future Features has been expanded so our readers may have a fuller idea of our plans for covering the Water and Sewage works field in the months ahead. Our aim is to present not only a wider range of subject matter dealing with the various aspects of treatment and disposal, but also to present articles describing the most recent developments of equipment and procedures.

Future Features appears on Page 8A of this issue.

Pennsalt Water Works Grade Chlorine

...made pure

Pennsalt chlorine gets "scrubbing tower" treatment for *extra* purity.

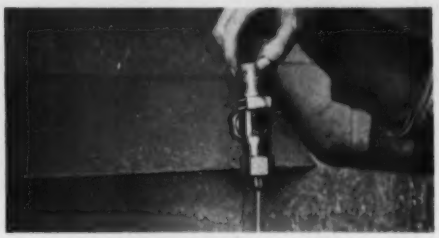
Pennsalt Water Works Grade Chlorine gets the added purification of special chlorine processing techniques pioneered by Pennsalt many years ago. This special processing removes trouble-making organics and traces of moisture. The result is a high quality chlorine that's ideal for dependable chlorination.

Pennsalt Water Works Grade Chlorine is available in 100- and 150-lb. cylinders, and in one-ton containers in multiple-unit rail cars. Pennsalt Ferric Chloride is available for fast sedimentation in sewage processing. Industrial Chemicals Division, PENNSALT CHEMICALS CORPORATION, Three Penn Center, Philadelphia 2, Pennsylvania.

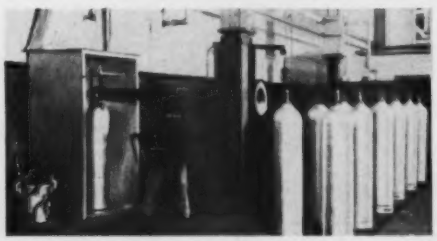
Pennsalt Chemicals
ESTABLISHED 1850

...stays pure

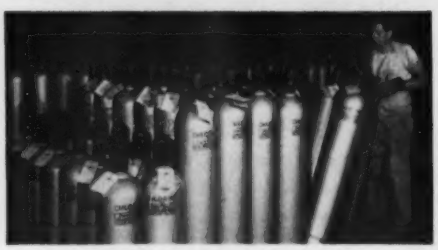
Before refilling, Pennsalt chlorine cylinders are carefully cleaned and inspected . . .



All valve parts completely reconditioned . . . valve is reassembled using all new packing . . .



Cylinders are cleaned and painted . . .



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Briefs

USAF'S Water Fluoridation Policy—A report of the policy and practices of the Air Force's fluoridation program especially designed to help improve the dental health of personnel children—Page 123.

A Monograph for the Selection of Pipe Classes was developed to facilitate the determination of pipe classes for conduits—Page 126.

Basic Biology of Stabilization Ponds considers the design and operation of stabilization ponds from the viewpoint of biological principles—Page 131.

Landscapes is a meditative essay by Partially Oriented who begins to wonder what would happen if project engineers became landscape artists—Page 137.

Epoxy-Vinyl Paint System describes the application and benefits of using vinyl coatings—Page 138.

Fusing the Phenol Frenzy challenges the view that this chemical is a Public Nuisance No. 1 and that its control is almost the control of water pollution itself—Page 140.

Theory and Practice of Activated Sludge Process Modifications—A review of recent developments wherein process efficiency, capital and operating costs have been reduced—Page 145.

Editorial—Comments on the need and desire for progress in the water works field entitled, "Dissolve the Apparent Need"—Page 151.

Hypochlorination Guide, Part IV, (Hypochlorite Feeding Equipment)—The concluding article of this series discusses equipment used for dispensing hypochlorites for disinfection and other treatment objectives—Page 152.

Split Treatment for Stabilization—The stabilization of lime softened water utilizes lime efficiently and enables the water plant operator to produce a quality product with minimum cost—Page 158.

Water & Sewage Works is published monthly with an extra issue in August. Subscriptions including the Reference Number issue in the U.S. and Canada, 1 year $5.00; 2 years $7.50; 3 years $10.00. Other countries $1.50 per year additional. Single copies 50c except Reference Number $1.00.

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Washington Viewpoint

There's so much money and so much work in the field of public health facilities, tucked away in so many places, in legislation already before Congress that it is becoming difficult to sort out. And it needs to be sorted to some extent, before you can decide which bills are worth following as the nation's lawgivers finally get down to serious work.

For your records, you might want this rundown; The various "Area Redevelopment" bills (S.1 and others) contain revolving funds of up to $390 million, to be used for construction of community facilities including water supply, sanitary sewers and the like, in the hope of attracting industry to chronically depressed areas; the "Health Facilities and Training" Act (S 719) would authorize spending some $600 million over a three year period for construction of hospitals, medical, dental and "public health teaching" facilities; various bills for expansion of the saline water program (S 100 and others) would jump available Federal money to $20 million a year over four years for loan to organizations wishing to build conversion plants or make studies.

Out of some $400 million (over four years) that would be provided under a Democratic bill (S 858) aimed at preventing "urban sprawl" by preserving open spaces within and between growing communities, a considerable amount would go for sanitary facilities, storm drainage (states would get loans to purchase open lands for parks and recreational areas); Federal funds available for air pollution control activities would be more than doubled under still other legislation; and an amount estimated at $250 million over several years would go for sanitary and water supply improvements under numerous bills aimed at urban redevelopment.

That's not nearly all, of course: You've already seen the Administration proposal (Blatnik bill) jump annual Federal grants for stream pollution abatement work to $125 million; and detailed legislation is still to come on the general problem of preservation of natural resources—in which pollution and future potable and industrial water supply plays a big part.

Two other matters of importance in this area were also before Congress in mid-March: Approval of a four-state compact to develop resources of the Delaware River Basin in Delaware, New Jersey, New York and Pennsylvania; and approval of a four-state Northeastern Water and Land Resources Compact between Connecticut, Massachusetts, Rhode Island and New Hampshire.

The two compacts differ considerably in that the Delaware agreement would set up a powerful commission charged not only with formulating comprehensive resources development plans, but carrying them out. It was estimated that the result could be a 50-year, $500 million program that would include regulation and operation of water and waste treatment plants, recreation facilities, ground water recharge and similar projects. The Northeastern compact would set up a commission charged basically with surveying needs and making recommendations, but not with construction, operation or enforcement.

You will also be interested in the outcome on the large group of so-called "wilderness" bills now before Congress, with at least tacit Administration backing. As you may know, these bills would convert huge areas of Federally-owned land, largely in Western states—some 55,000,000 acres—into "wilderness" areas. That would preclude practically any type of development within these areas, Including construction of dams for water supply, or works to control such pollution as that

caused by silt and vegetable matter, unless special exceptions were made by the President through one of the Executive Department agencies (Interior or Agriculture). Exactly this point—the possible loss of developable water supply without special dispensation—obviously worried Western Senators in early hearings. Chances of passage of such legislation has to be rated better than even, but strong efforts will be made to clarify such water rights.

* * *

Although the details of the Administration's natural resources program had not reached Congress in mid-March, the general outlines were strong enough to confirm predictions in these columns: Very definitely, there will be calls for "new starts" on water control projects, both by the Bureau of Reclamation and the Corps of Engineers, and the Administration will look with favor on the many independent proposals already before Congress calling for work on specific pet projects in home states. In addition, the shift in emphasis to public development of power projects could mean greater speed in getting new work under way.

However, the announcement of the shift toward public development was far from unanimously well received, and will quite probably be the source of controversy as the Congressional session develops. Note, too, that Mr. Kennedy may have made a major political error in his message on natural resources: He said that policies of the previous Administration have been responsible for "loss of lives and property". The statement was seriously resented on the floor of both Houses.

* * *

And, on the subject of natural resources, there was a discouraging note for Western areas in the monthly report of the Bureau of Reclamation, as of February field surveys: Subnormal precipitation and scant now cover, coupled with generally low reservoir holdover storage, forecast short water supplies for the 1961 crop season in many parts of the West.

* * *

First definite move to sidetrack the drive for establishment of a cabinet-level Department of Urban Affairs appeared recently in the House—a resolution calling for creation of a Select Committee on Urban Affairs, to study the overall problems of urbanization, make recommendations for future action. It is interesting that this proposal was introduced by a Republican (F. Bradford Morse of Massachusetts), but is in line with the rather obvious feelings of the Kennedy Administration: Better to put off a fight on this proposal this year, and get through the 16-point "must" legislation. Such a Select Committee would provide a good answer to campaign pledges, since something would be in process.

* * *

In Washington itself, city officials found that labor costs have stalled a mammoth job started last fall to try to eliminate some of the pollution in the sluggish Potomac River. About half of the city's sewer lines also carry storm water, and in turn overflow into storm water mains discharging without treatment into the river during periods of heavy rainfall. Last fall, a house-by-house plumbing job was started in some older neighborhoods, to connect homes to exclusively sanitary discharge lines. But a Labor Department decision that plumbers must be paid $4.50 an hour immediately put costs beyond available funds. A hearing on possible downward revision of the pay scale is scheduled for April.

* * *

Consultants called to work with government departments could get a pay raise if Congress approves another try on this matter embodied in a new Senate bill (S 884). It calls for a maximum of $100 per day, compared to the present $50 a day. The subject is a perennial, as many engineers know: This year, it is backed by the Commerce department; last year, Interior tried to get a similar raise.

Still another National conference on water problems—this one sponsored by agricultural and reclamation interests—went through a three-day session in Washington at the end of March. Speakers includedSenator Robert S. Kerr of Oklahoma; E. L. Hendricks, chief of surface water branch, U. S. Geological Survey; Grant Bloodgood, chief engineer for the Bureau of Reclamation at Denver. Sponsors were the National Reclamation Association and the National Association of Soil Conservation Districts.

* * *

News—Here & There

Sea Water Conversion Plant

The erection of 12 evaporator bodies initiates construction progress of a 1 mgd sea water conversion plant being built at Freeport, Texas by the Chicago Bridge & Iron Co. Designed to produce fresh water from the sea for less than $1 per thousand gallons, the experimental plant will be operated by the Office of Saline Water, Department of the Interior. Conversion will be by the long-tube vertical multiple effect distillation process.

The tank in left foreground is a clarifier-thickener reservoir for magnesium hydroxide crystals, which are recycled in the system to maintain cleanliness. The plant is scheduled to begin operation in May, 1961.

European Course in Sanitary Engineering

The European Course in Sanitary Engineering, organized by the Technological University at Delft and the Netherlands Universities Foundation for International Co-operation (NUFFIC) with the assistance of the Organization for European Economic Co-operation (Paris) and the World Health Organization (Copenhagen), will be held for the second time from October 23, 1961 to July 17, 1962.

The study will be based on a broad foundation of fundamental subjects like social backgrounds, hygiene, chemistry, microbiology and hydrology. These lectures will be followed by discussions of the scientific and practical aspects of modern groundwater recovery and water supply, storage and purification of sewagewater, and the disposal and disinfection of solid wastes. As these subjects cover a wide field, participants will be able to specialize further when choosing subjects for the design exercises which deal with the details of either water supply or disposal of liquid and solid wastes.

The faculty will be headed by Prof. W.F.J.M. Krul, professor of sanitary engineering at the Technilogical University at Delft; whereas Ir. L. J Mostertman, director of studies of the International Course in Hydraulic Engineering, will be charged with the daily direction of the Course.

The tuition fee for the Course is 2000 Dutch guilders (approx. £ 190.) Closing date for applications: July 31st, 1961.

Further particulars are to be found in the prospectus which will be sent upon application to NUFFIC, 27, Molenstraat, The Hague, The Netherlands.

Commercial Standard for Plastic Sewer Pipe Revised

Developments within the plastic sewer pipe industry are reflected in a recommended revision of Commercial Standard CS228-60, Plastic Drain and Sewer Pipe and Fittings. Prepared in cooperation with The Society of the Plastics Industry, Inc., and the National Bureau of Standards, by the Commodity Standards Division,

CONTINUED ON PAGE 10A

W&SW FUTURE FEATURES . . .

Manuscripts Scheduled for the Next Few Issues of W&SW

Discussion of Synthetic Detergents—Part 1

Louis G. Campenni
FHA Zone Engineer, Bayside, N. Y.

Discusses synthetic detergents, their impact on the ground water of Suffolk County, L. I. Also describes FHA activity during 1957-58. Part 2 covers syndet problem in New England and reviews published reports about well construction.

Evaporation Suppression Research—Part 1

Joseph B. Franzini
Stanford University, Stanford, Calif.

Reviews benefits of evaporation suppression. Describes monomolecular film and problems arising from attempts to control evaporation from reservoirs. Part 2 reports on work being done to locate more effective chemicals, study of water to be saved and costs.

Velocity of Flow in Partly Filled Pipes

Richard Pomeroy
Pomeroy and Associates, Pasadena, Calif.

Develops equations which modify Manning's formula. Investigation applies to pipes of circular cross-section.

Increasing Reservoir Storage with Bascule Gates

Gordon E. Thomas
Metcalf & Eddy, Boston, Mass.

Describes means of increasing reservoir capacity. Emphasizes use of bascule gates and illustrates use in several installations.

Algae Growth Rate

Wesley O. Pipes
Northwestern University, Evanston, Ill.

Concludes that some organic and some nitrogenous compounds will accelerate growth of stabilization pond algae.

Application of Fluorides to Water

William T. Ingram
New York University, New York. N. Y.

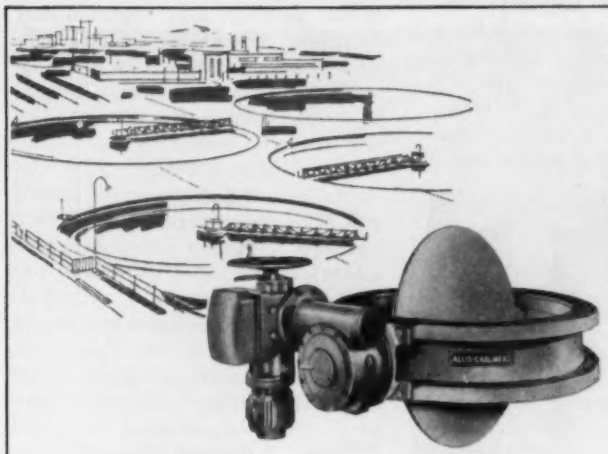
Report of extensive studies of fluoridation practices in twenty major U. S. cities. Includes data about costs of chemical, equipment, operation, and maintenance.

Coagulant Aids as Filter Aids

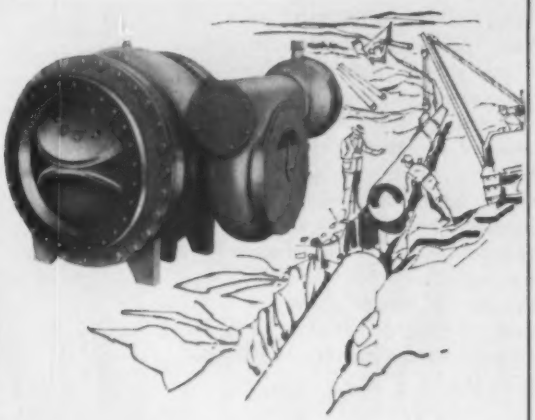
W. R. Conley and R. W. Pitman
General Electric Co., Richland, Wash.

Discuss use of coagulant aids applied to filter influent. Results in chemical treatment costs savings and improves filter operation.

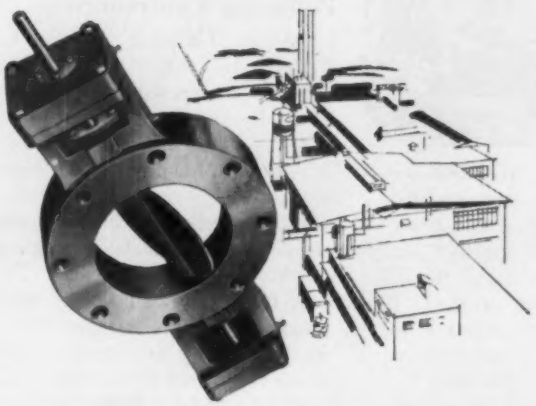
ALLIS-CHALMERS



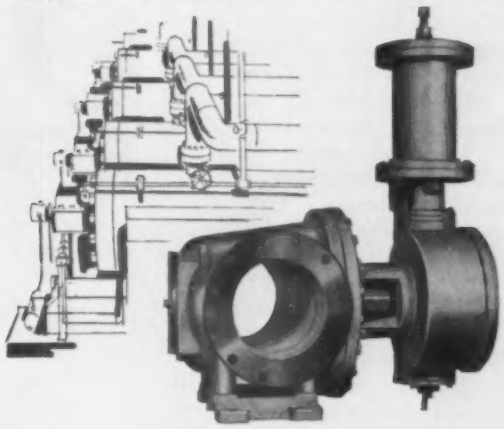
BUTTERFLY VALVES — For liquids or gases — uniform control in all positions, fast positive regulation and closure, minimum pressure drop. Compact and lightweight. Sizes from 1 in.



BALL VALVES — Easy manual shutoff under adverse conditions, and up to 150 psi. Slight wedging action gives unusually drop-tight closure. Sizes: 12 to 48 in.



WAFER VALVES — A new design of butterfly valves with space-saving flexibility, suited to most any type of operation. Sizes from 3 to 36 in., including high-pressure types.



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A-1381

News—Here & There

CONTINUED FROM PAGE 8A

Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce, the recommended revision was recently submitted to the industry for consideration and acceptance.

Essentially, the revision provides a means of broadening the application of plastic drain and sewer pipe to include larger sizes of pipe for use in sanitary sewers and storm sewers.

Limited copies of the recommended revision, designated TS-5527, are available on request from the Commodity Standards Division, U. S. Department of Commerce, Washington 25, D. C.

W.S.U. Expands Sanitary Engr. Program

Washington State University at Pullman, Wash., will expand its graduate program in environmental health (sanitary) engineering beginning in the fall of this year. In addition to a program of studies emphasizing water supply and waste water disposal leading to the degree of Master of Science in Sanitary Engineering, a strong option in radiological health will be provided. This option is intended to adequately train engineers for work in radiological waste disposal and protection.

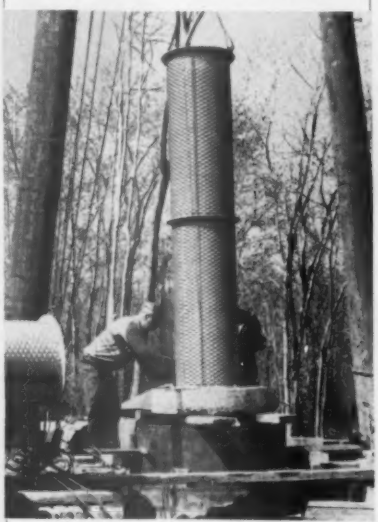
New courses in sanitary engineering and microbiology will strengthen the science foundation which will be required of future candidates for degrees. Many of these courses are open to qualified students majoring in various science areas as well as to engineers.

These programs are supported by grants from the USPHS and related areas.

Research assistant-ships are available for qualified candidates. These permit the student to carry two-thirds of a semester load of course work in return for twenty hours of project research, much of which is supported by USPHS grants. Work under way includes studies of the quality of return flows from irrigation, pesticides in natural waters, and anaerobic-aerobic sewage lagoons.

Further information is available from: G. H. Duncan, Professor of Sanitary Engineering, Washington State University, Pullman, Wash.

Pictured is the largest producing well in England, which has a capacity of 5 million gpd. Large well screens made of type 304 stainless steel are used to screen sand, small stones and other unwanted material from the well.



The men are bolting two sections of stainless steel screening to a concrete base. Six 5 ft sections were bolted together and lowered to the bottom of this 72 ft well; each section weighed 240 lbs. These screens in other installations have withstood driven pressures of 40 to 50 tons.

Allegheny Ludlum Steel Corp., manufactured the 3/16" steel plate, and the National Perforating Corp. (Clinton, Mass.) punched small slots resembling louvres to a specified size. The plate was then rolled into a cylinder.

Greco To Address Appalachian Short Course

Mr. Edward C. Greco, United Gas Corporation, Shreveport, La., incoming president of the National Association of Corrosion Engineers will present the opening address at the Sixth Annual Appalachian Underground Corrosion Short Course. The course is held annually at the West Virginia University, Morgantown, West Virginia.

Dates this year's school are June 6, 7 and 8, 1961. Present scheduling of the program lists approximately 65 papers covering basic, intermediate and advanced education of corrosion control as related to underground pipe, cable and water systems. Ten new subjects related to these catagories will be included.

Also included in the course agenda are field demonstrations of control corrosion equipment, a three-hour corrosion control open discussion and exhibits of materials and equipment. This course is considered the largest of its kind in the world and has educational courses available for all job levels. Further information may be obtained by contacting Mr. John H. Alm, 2 Gateway Center, Room 605, Pittsburgh 22, Pa.

De Paul Holds Water Pollution Conference

"Water Pollution in the Great Lakes Area" will be the subject of a two day conference to be held May 15-16, by DePaul University of Chicago. Speakers at the conference will discuss the growing national problem of water pollution, its economic, health and recreation effects upon the people in the Great Lakes region.

"Water pollution," said Father Cortelyou, chairman of the school's Biological Sciences Department, "is not only a grave and growing menace to the well-being of our country, but it is also a problem largely overlooked.

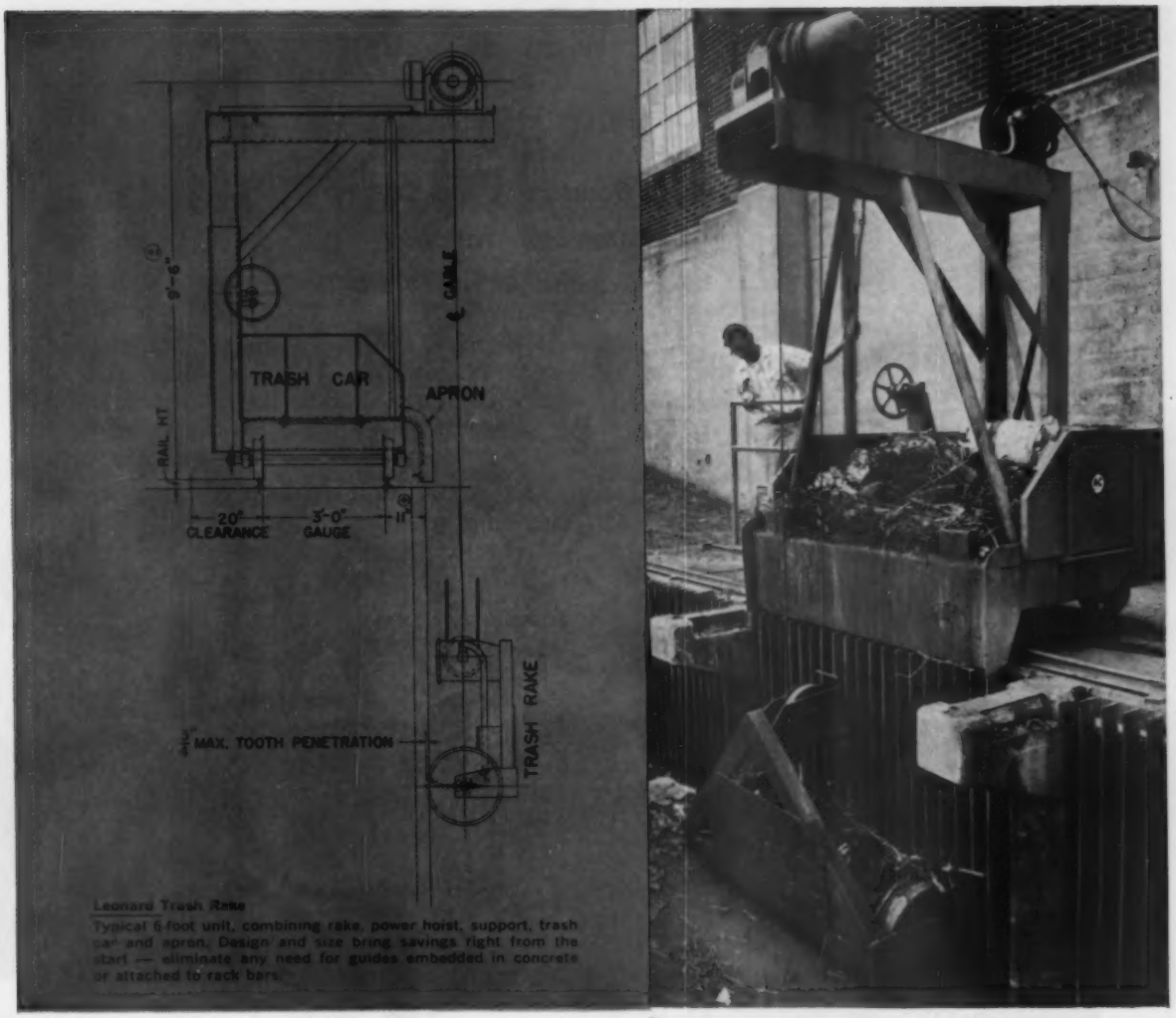
"It is misunderstood because most people think of it in terms of human, or domestic waste. Overlooked is the fact that in today's urban and industrialized society we are faced with some water problems that did not exist even 10 or 15 years ago.

"Today pollution is the result of complicated and interrelated factors that are only in part—and often a small part—caused by domestic waste."

Father Cortelyou pointed out that advances in technology have created new problems in scientific areas that exceed our factual knowledge concerning water pollutants.

He described the purpose of the conference to "awaken the interested citizen to the danger that confronts the rivers and lakes of the great American Midwest."

ALLIS-CHALMERS



Leonard Trash Rake

Typical 6-foot unit, combining rake, power hoist, support, trash car and apron. Design and size bring savings right from the start — eliminate any need for guides embedded in concrete or attached to rack bars.

Cleans up costly head losses

. . . rakes-in savings enough to pay for itself!

Here's intake-trash removal so far ahead of hand methods that *"once sold is sold forever!" Leonard* trash rake installations deliver savings both in reduced head loss and labor costs. And they bring a permanent solution to shortages of people to do the job — make trash removal a one-man operation.

Leonard **trash rakes roll right down your existing rack bars whether vertical or inclined. Because no channel guides are needed, they freely ride over stubborn obstructions, dig them loose, scoop trash up to the waiting receptacle or car. Self-dumping units also are available—both log-grapple and regular models.**

Leonard **is an Allis-Chalmers trademark.**

With Allis-Chalmers trash rakes even the initial investment is low. Width is held to the logical minimum required for adequate handling of trash . . . standard 6- and 8-foot sizes. Larger units special. Your nearby A-C representative has full details. Or write Allis-Chalmers, Hydraulic Division, York, Pa.

A-1307

"Good thing this is simple...
Ah hates bein' watched
when Ah'm workin'"

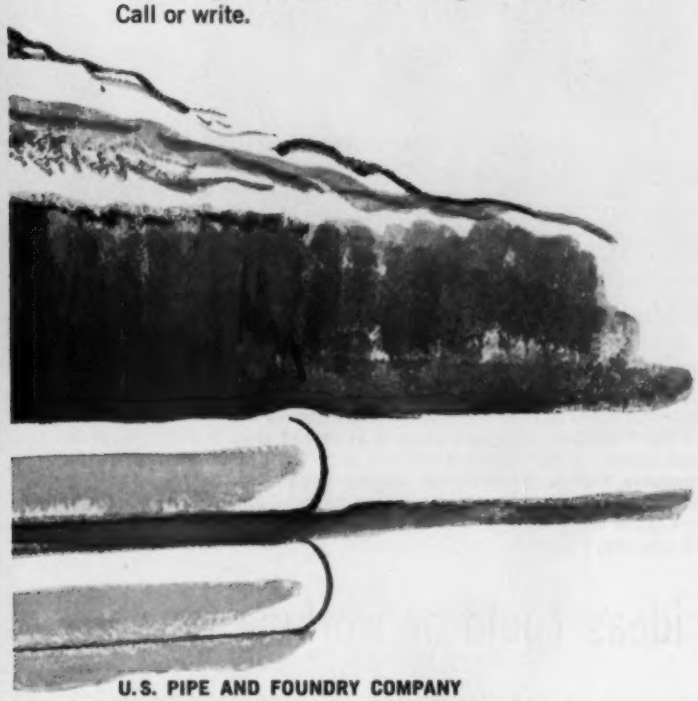
U.S. cast iron PIPE FOR WATER, SEWERAGE AND

worth looking into!

Fact! Whenever . . . wherever Tyton Joint® pipe goes into the ground it wins more than its share of attention.

And why not? Tyton's so simple . . . so easy to assemble . . . it's a joy to watch. Only one accessory needed—a rubber gasket. No bell holes. No nuts, bolts or caulking equipment. Reduces weather worries too . . . Tyton can be laid in rain or wet trench.

Simple, speedy, sure, Tyton Joint* pipe is one big answer to today's problem of steadily rising costs. Get the money, time and labor-saving facts today. Call or write.



U.S. PIPE AND FOUNDRY COMPANY
General Office: Birmingham 2, Alabama

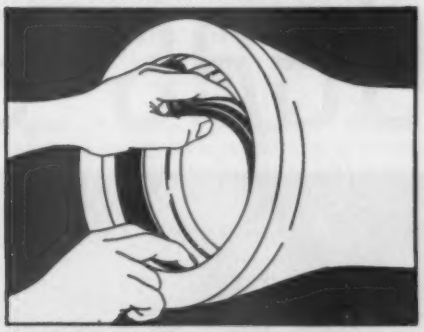
A Wholly Integrated Producer from Mines and Blast Furnaces to Finished Pipe.

*U.S. Patent No. 2,953,398

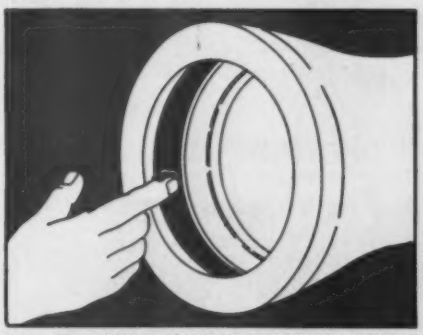
INDUSTRIAL SERVICE ® CAST IRON

TYTON®

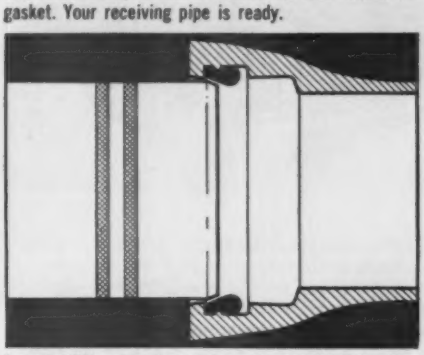
ONLY FOUR SIMPLE ACTIONS



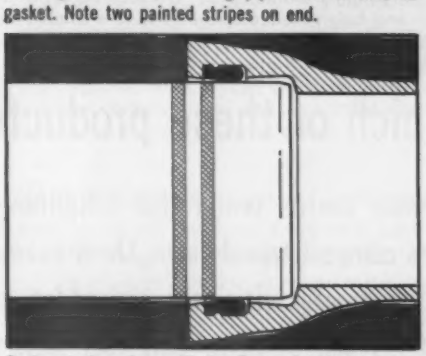
Insert gasket with groove over bead in gasket seat . . . a simple hand operation.



Wipe film of Tyton Joint® lubricant over inside of gasket. Your receiving pipe is ready.

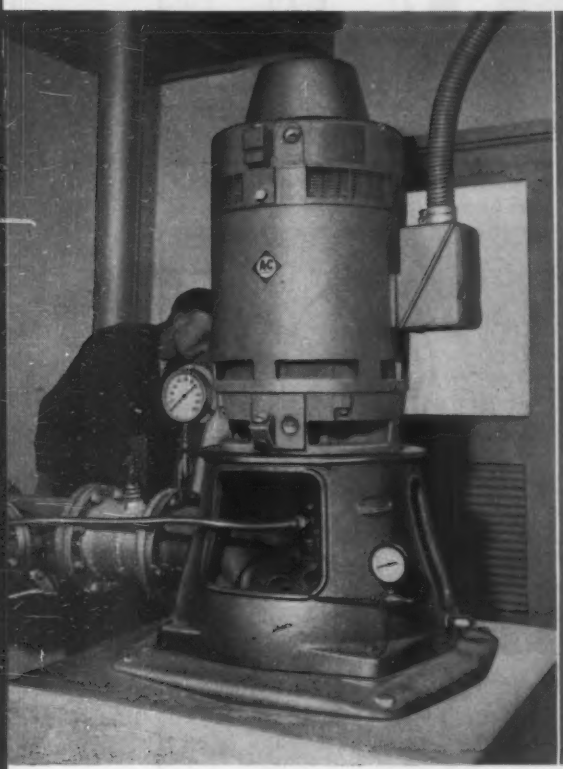


Insert plain end of entering pipe until it touches gasket. Note two painted stripes on end.



Push entering pipe until the first painted stripe disappears and the second stripe is approximately flush with bell face. The joint is sealed . . . bottle-tight, permanently! The job's done . . . . fast, efficiently, economically. Could anything be simpler?

ideas and news:



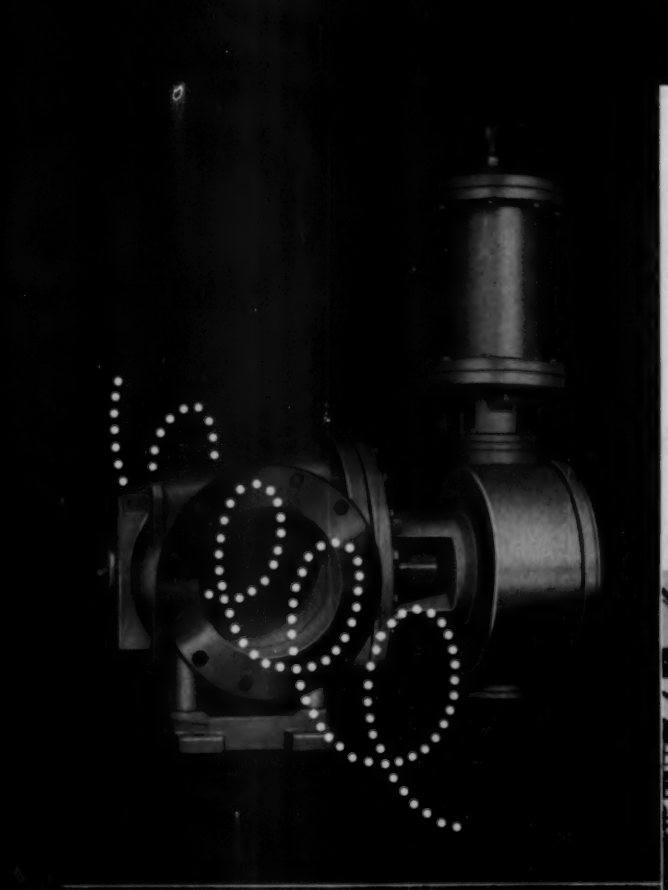
More hp in a smaller package . . . Redesign of the Allis-Chalmers hollow-shaft motor has resulted in a more compact unit. New, attractive styling makes it an asset to any pump installation. Oil-lubricated guide and thrust bearings, large accessible oil-fill holes, and easily readable oil level gauges simplify maintenance. Double end ventilation and fully guarded openings assure trouble-free service.

Control centers cut costs . . . You save space, simplify wiring and reduce inspection and maintenance expenses with new Allis-Chalmers low-voltage motor control centers. Plug-in terminal blocks and drawout construction cut inspection time by making it quick and easy to withdraw or remove control units. Pushbuttons and pilot lights are mounted on the removable frames to eliminate failures common with hinged wiring. Special connectors make it impossible for bus connections to loosen. Extra-heavy bus bracing makes additional bracing unnecessary when you add capacity.

Which of these productive ideas could be working for you?

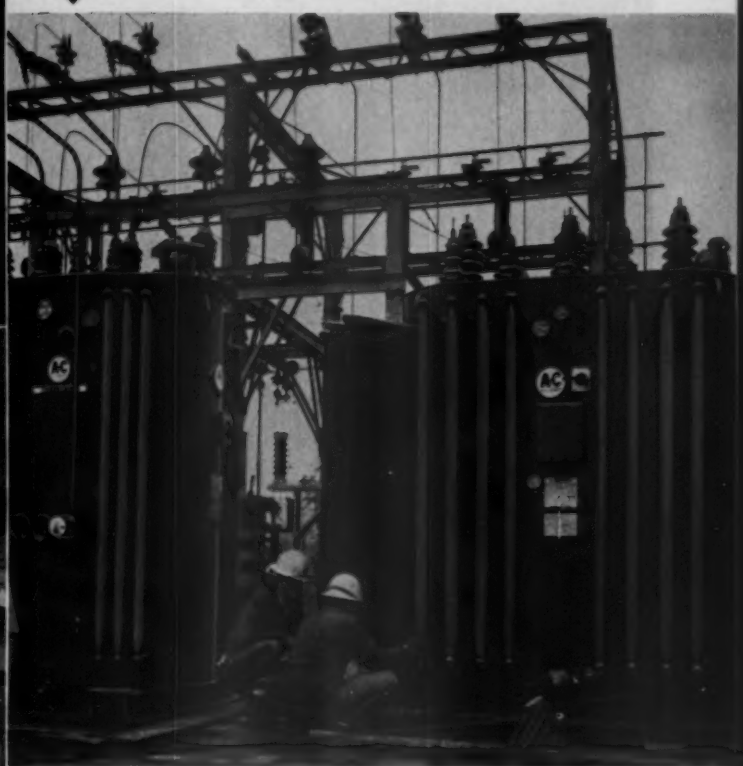
A motor control center that simplifies maintenance. A valve that offers zero flow resistance. A more compact transformer. These examples demonstrate the extra value that is standard with A-C . . . the greater efficiency and added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industries Group, 904 South 70th Street, Milwaukee 1, Wisconsin.

Rotovalve is an Allis-Chalmers trademark. A-1458



"Open road" for unrestricted flow . . . This ROTOVALVE, when wide open, offers no greater resistance to flow than a straight pipe of equivalent length. Promotes lower pumping costs. Actually seats itself tighter with use. And special shut-off characteristics reduce water hammer. All moving parts are totally enclosed, yet easily accessible.

Transformers "grow up" but don't get bigger . . . New Allis-Chalmers transformers deliver as much as a 30% increase in kva without any increase in size or weight. This permits replacement of old transformers without altering base mountings or overhead structures. The unit being installed has twice the rating of the neighboring 2500-kva transformer.



Stainless steel "scorns" corrosion . . . It's standard with all Allis-Chalmers tray-type deaerator internals. This 90,000 lbs. per hour "package" unit removes oxygen and other corrosive gases besides heating boiler feedwater. Heating and distributing tray design provides greater spillage edge — extra-efficient air separating trays remove more oxygen and gases through full counterflow design. Protects boiler and associated steam and condensate equipment from corrosive attack.

ALLIS-CHALMERS PRODUCTS: Look to Allis-Chalmers for compressors; controls; coolers; crushers; earth-moving equipment; engines; generators; industrial systems; kilns; lift trucks; motors; pumps; rectifiers; screens; electrical generation and distribution equipment; tractors; transformers; unit substations; valves; water conditioning equipment.

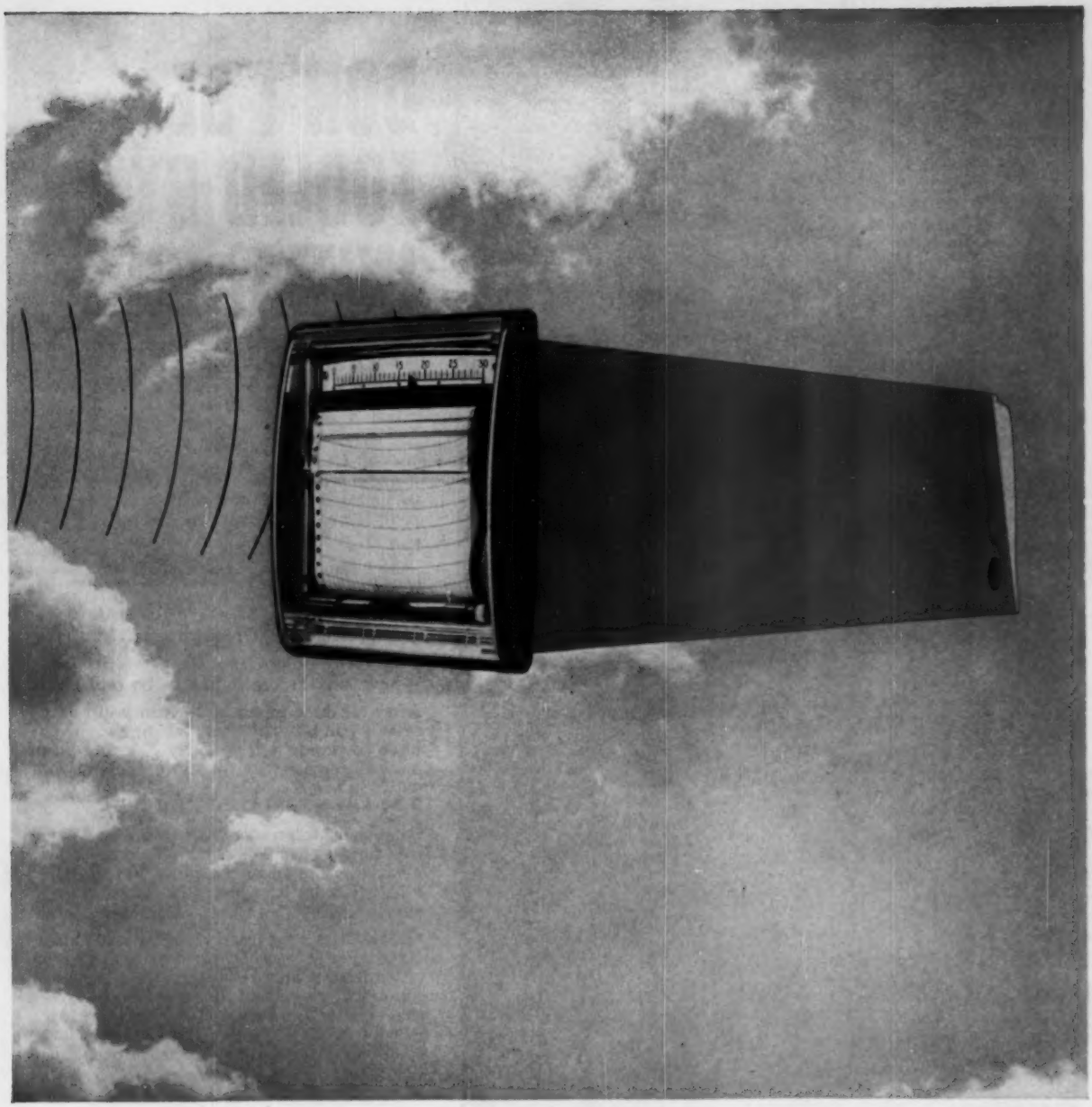
ALLIS-CHALMERS

new, 2-second cycle, all-electronic eliminates mercury switches...

A giant step forward in the science of telemetering measured variables — this is Foxboro's new telemetering system.

Completely electronic, the system abandons earlier mechanical means of producing a pulse-duration signal. Dry reed switches replace troublesome mercury switches . . . a photo-diode switch replaces the mechanical cam switch. There are no synchronization problems . . . no vacuum tubes . . . no periodic maintenance.

Standard impulse-duration cycle on the new Foxboro telemetering system is 2 seconds — 4 times as fast as any other standard system. The signal can be carried over any



telemetering system makes maintenance "plug-in simple"

transmission medium. Modular construction makes servicing easy as "plugging-in" a new component.

This is the telemetering system all industry has been asking for. For full details, write for Bulletin 17-12. Or better yet, ask your Foxboro Field Engineer for the complete story. The Foxboro Company, 894 Neponset Avenue, Foxboro, Mass.

FOXBORO

REG. U. S. PAT. OFF.

*Reg. U.S. Pat. Off.

DON'T BE FOOLED BY INITIAL PIPE COSTS...

Certain factors concerning the type of pipe to be used for a proposed water or gas project must be examined carefully:

First

—how much does the pipe cost, compared to other types?

Second

—how often will it require repair?

Third

—how long before it has to be replaced?

After all, how much money do you really save if you buy the cheapest pipe . . . then have to repair it frequently . . . and *then* have to replace it within a decade or two?

You save with cast iron pipe

Sometimes the first cost of jobs where cast iron pipe is specified, is higher than similar projects using cheaper pipe. Yet, in the long run, cast iron pipe costs *less!* Here's why:

- Cast iron pipe rarely requires repairs. Its rugged construction, corrosion-resistant qualities and bottle-tight rubber-ring joints will withstand the most severe pressures. Once an investment is made in cast iron pipe, it is usually your first and last cost because of the absence of maintenance or repairs.

- Cast iron pipe is built to *last*—98 American cities will testify to that. They've had cast iron pipe installations in constant use for over a century! In fact, in Versailles, France, they're still using cast iron pipe water mains that were laid in 1664! Once cast iron pipe is in the ground, it stays there!

Don't be fooled by "low-cost" pipe. Insist on the pipe that will actually save you money over a period of years . . .

In Nebraska—Here a section of cast iron pipe is being relocated. Twenty-five years old, the pipe is still in excellent condition—has never required major repair . . . or replacement.

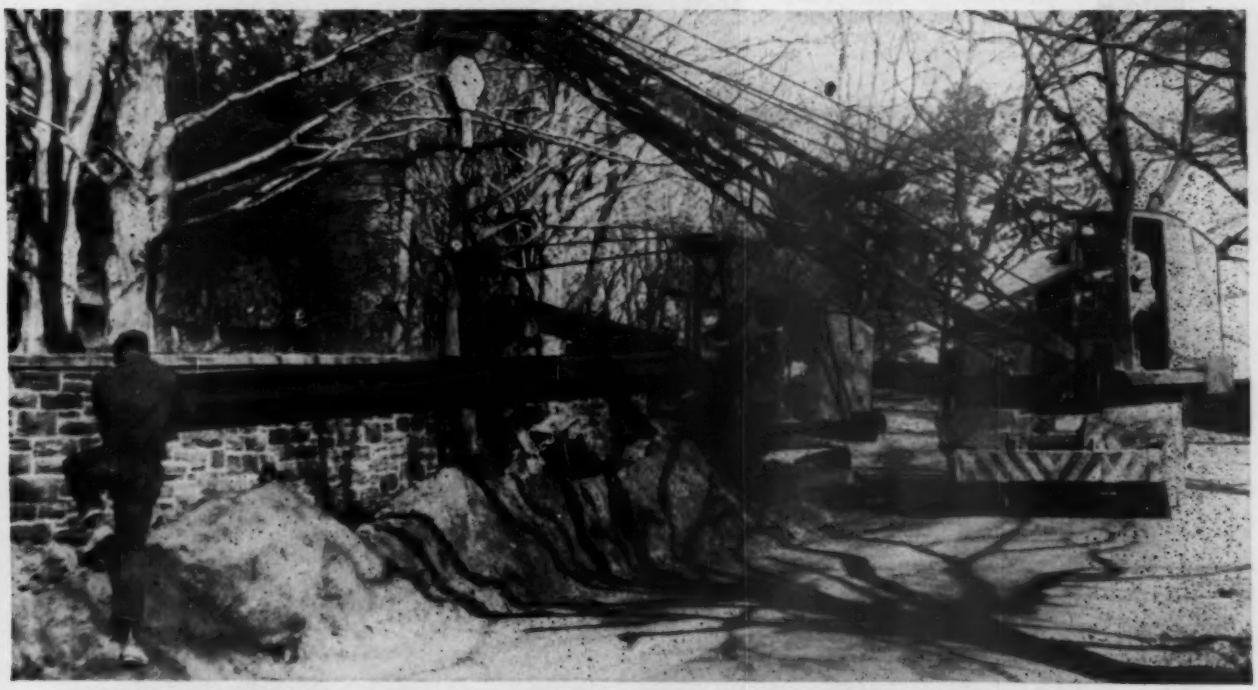
Rely on CAST IRON PIPE

In Indiana (above)—"All-weather" cast iron pipe is quickly installed despite wet trench conditions. Slip-on joints were easily assembled, with one workman using a crowbar.

In Kansas (above)—36" cast iron water main. Another part of this main was floated out of its trench by a heavy downpour. Later a 150 psi water test revealed no leaks in the slip-on joints!

In Pennsylvania (below)—This 16" cast iron pipe is being installed as fast as the trench hoe can prepare the trench.

Handy lengths and slip-on joints make cast iron pipe easy to handle, even in crowded neighborhood sectors; require less labor.



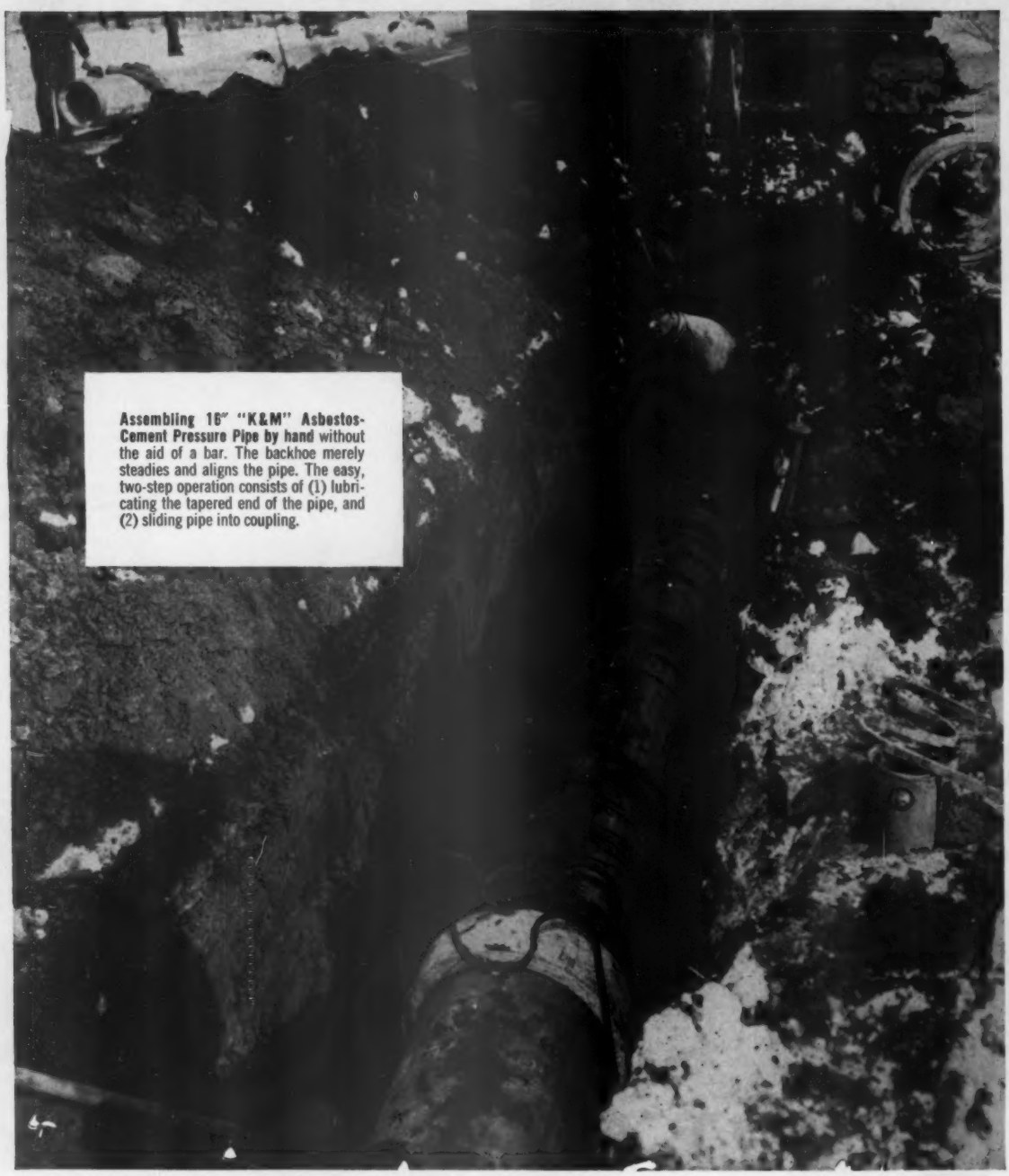
CAST IRON PIPE

THE MARK OF THE 100-YEAR PIPE

Cast Iron Pipe Research Association,
Thos. F. Wolfe, Managing Director, 3440 Prudential Plaza, Chicago 1, Illinois

"'K&M' ASBESTOS-CEMENT

LAYS AS FAST AS



Assembling 16" "K&M" Asbestos-Cement Pressure Pipe by hand without the aid of a bar. The backhoe merely steadies and aligns the pipe. The easy, two-step operation consists of (1) lubricating the tapered end of the pipe, and (2) sliding pipe into coupling.

PRESSURE PIPE

A SHOVEL DIGS..."

G&B Construction, Inc., Youngstown, Ohio, installs 4½ miles of "K&M" Asbestos-Cement Pressure Pipe for the Austintown District of Mahoning County, Ohio

"You can lay 'K&M' Pipe as fast as a shovel can dig. There is nothing that will hold you back with this pipe. When you can lay a 16" water line, and it goes in as easy as an 8" water line, what more could you ask? They've got a good joint with that FLUID-TITE® Coupling . . . the pipe is wonderful to put together. Of all the 'K&M' Pipe we've laid, we never had a coupling break."

Those are the comments of Louis Gulfo, partner with Mike and James Bertilacci in G&B Construction, Inc. They installed "K&M" Asbestos-Cement Pressure Pipe in bitter cold, during February and March 1960. However, neither rain, snow, nor mud interrupts the installation of this modern pipe. The exclusive, patented "K&M" FLUID-TITE Coupling and the simple fitting procedures required make assembly easy.

Little or no maintenance will face Mahoning County, which built and will operate the system for a year, or the City of Youngstown, Ohio, which will then take it over. Being non-metallic, "K&M" Asbestos-Cement Pressure Pipe won't rot, corrode, or tuberculate, and is immune to electrolysis. The suppliers of this pipe were Trumbull Plumbing Supply Co., Warren and Youngstown, Ohio.

Now, in addition, you may use quality "K&M" Plastic Pressure Pipe in the same system with "K&M" Asbestos-Cement Pipe, if desired.

Write today for more information on "K&M" Asbestos-Cement Pressure Pipe to: Keasbey & Mattison Company, Ambler, Penna. Dept. P-941.

K·M
BEST IN ASBESTOS

Keasbey & Mattison at Ambler

Left to right: Louis Gulfo, G&B Construction, Inc.; Dale MacCleary, sales manager, Trumbull Plumbing Supply Co.; James Bertilacci, G&B Construction, Inc., Burke Lyden, Asst. Chief Engineer, Youngstown, Water Dept., Jim Bisciglia, Asst. Engineer, Mahoning County, and J. Henry Painter, Trumbull Supply Company.

3 miles of 16" "K&M" Asbestos-Cement Pressure Pipe were installed. Here, we see it ready for installation along Webb Road, in Austintown Township. In branching from the 16" water line, Mahoning County used 1 mile of 12" "K&M" Asbestos-Cement Pressure Pipe and ½ mile of 8" "K&M" Asbestos-Cement Pressure Pipe. Specifications call for 90 lbs. pressure when line is in operation serving 16,000 residents.

Three County Commissioners from Ohio report:

"For economy and performance, Transite Water Pipe is still our main choice."

Belmont County, Ohio, Commissioners William H. Dorsey, Austin C. Furbee and Louis T. Salvador.

"Belmont was one of the many counties that experienced a building and population boom. Fortunately, our officials had the foresight to recognize its ultimate effect on our water system and service. As early as 1953, plans were made to meet future demands. Surveys were made . . . operating men and engineers were consulted . . . pipe materials investigated.

"In 1956, we extended our water system 13 miles. The installation and operating economies are now a matter of record. The successful performance of the extension is attributed to careful planning, helpful advice and, in part, to the selection of Transite Pipe.

"When we began designing another expansion of the system for 1960, our previous experience made Transite the main choice. The Belmont Water System now has 53 miles of Transite installed in rocky terrain and corrosive soils. The excellent performance of the first 13-mile section leads us to believe that Transite will provide economical maintenance and operation for many years."

For the full Transite® story, write Johns-Manville, Box 14, WS-4, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

JOHNS-MANVILLE PRODUCTS

JOHNS-MANVILLE
TRANSITE PIPE
THE WHITE PIPE THAT PROTECTS PRICELESS WATER

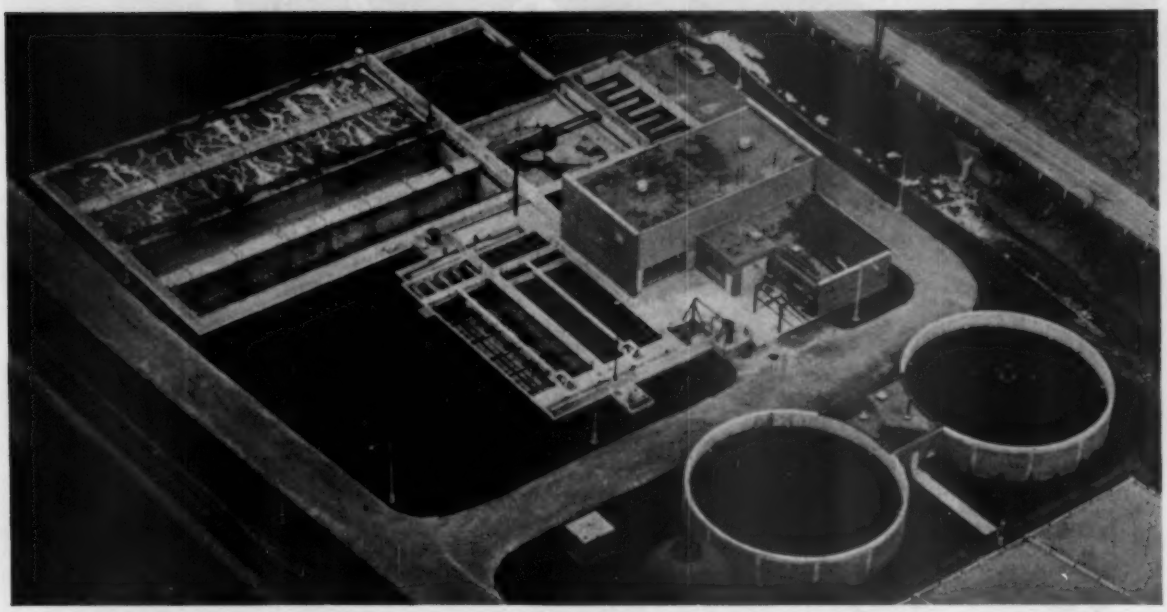
Pleasant Hills

Nestled among some of the most beautiful hills surrounding busy metropolitan Pittsburgh is the attractive community of Pleasant Hills, Pennsylvania.

This rapidly growing suburban area is not only providing gracious living for its residents but also effective and modern sewage treatment facilities.

Consoer, Townsend and Associates, Consulting Engineers, designed the Pleasant Hills plant which includes two P.F.T. 65′ Floating Cover Digesters and P.F.T. Gas Safety Equipment.

Pleasant Hills will dedicate its new plant this year. P.F.T. congratulates the community and its civic leaders for their progressive thinking and planning.



Aerial shows P.F.T.'s two 65' Floating Covers at new plant

P.F.T.

waste treatment equipment exclusively since 1893

PACIFIC FLUSH TANK CO.

4241 RAVENSWOOD AVENUE, CHICAGO 13, ILLINOIS

PORT CHESTER, N.Y. • SAN MATEO, CALIF. • CHARLOTTE, N.C. • JACKSONVILLE • DENVER

Wedge-Lock®

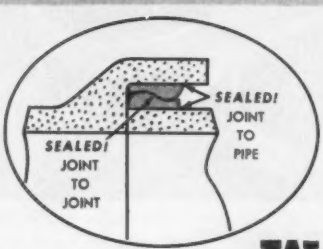
THE JOINT
with the

Full Circle
OF
PROTECTION

MINIMUM INFILTRATION!

ROOT-TIGHT SEAL!

FAST INSTALLATION!



When you install Vitrified Clay Pipe with Wedge-Lock Factory-Made Joints, you leave nothing to chance. Wedge-Lock pre-cast Joints are bonded to bell and spigot . . . snap together instantly . . . seal the entire circumference of the pipe to reduce infiltration and resist roots. Always specify Wedge-Lock, your Full Circle of Protection against infiltration . . . root problems . . . job delays . . . ultimate high cost resulting from costly repairs or maintenance.

Write to listed manufacturers for literature or an actual Wedge-Lock demonstration

Wedge-Lock CLAY PIPE

THE FACTORY-JOINTED CLAY PIPE AVAILABLE NATIONALLY FROM LOCAL MANUFACTURERS

Order Wedge-Lock from any of these Vitrified Clay Pipe Manufacturers:

Cannelton Sewer Pipe Company..Cannelton, Ind.
The Clay City Pipe Company....Uhrichsville, Ohio
The Evans Pipe Company.....Uhrichsville, Ohio
Graff-Kittanning Clay Products..Worthington, Pa.
Larson Clay Pipe Company.....Detroit, Mich.
The Logan Clay Products Company..Logan, Ohio
The Robinson Clay Product Co......Akron, Ohio
The Stillwater Clay Products Co...Cleveland, Ohio
Superior Clay Corporation.....Uhrichsville, Ohio

WLC-159-165-A

NEBRASKA COMMUNITIES SELECT COILFILTERS

. . . WITH EMPHASIS UPON FRESH SOLIDS DEWATERING

OGALLALA
Fresh Solids
Cons. Eng. Nosky & Hickey

NORFOLK
Fresh Solids
Cons. Eng. Leo A. Daly Co.

COZAD
Fresh Solids
Cons. Eng. Nosky & Hickey

KEARNEY
Fresh Solids
Cons. Eng. Henningson, Durham & Richardson

OMAHA
Digested-Activated
Cons. Eng. Henningson, Durham & Richardson

EAST SARPY CTY.
Fresh Solids
Cons. Eng. B. H. Backlund & Assoc., Inc.

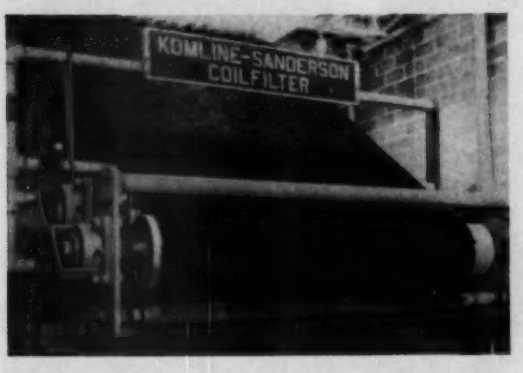
BEATRICE
Fresh Solids
Cons. Eng. Henningson, Durham & Richardson

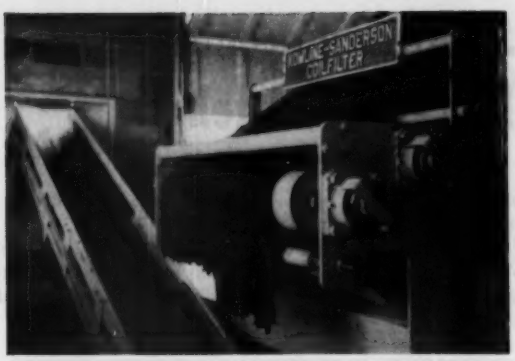
FAIRBURY
Fresh Solids
Cons. Eng. Henningson, Durham & Richardson

HASTINGS
Fresh Solids
Cons. Eng. Henningson, Durham & Richardson

SUPERIOR
Fresh Solids
Cons. Eng. Mousel & Wright

HOLDREGE
Fresh Solids
Cons. Eng. Henningson, Durham & Richardson





Since the first Coilfilter installation in the state, in 1957 at Hastings, Nebraska communities have chosen Coilfilters exclusively for sewage sludge dewatering.

Of the eleven installations named above, ten are for dewatering fresh solids, indicative of the popularity and reliability of that type of sludge dewatering.

Whatever the type of sewage sludge to be dewatered, Coilfilters have proved, time after time, that they can outperform all other sludge dewatering devices.

KOMLINE-SANDERSON ENGINEERING CORPORATION

PEAPACK, NEW JERSEY • BRAMPTON, ONTARIO, CANADA

MANUFACTURER OF COILFILTER SLUDGE VACUUM FILTERS AND AUXILIARY EQUIPMENT FOR DEPENDABLE FRESH SOLIDS DEWATERING

Newport News rack rakes . . . minimum-manpower way to keep water intakes free of debris

Newport News mechanical rack rakes are power-operated rakes for cleaning trash racks at water intakes, including those at hydro-electric plants, steam plants, pumping stations, and similar installations throughout this country and abroad. Under ordinary conditions, one man per shift keeps racks clean for a dozen bays.

Operate in channel guides for maximum cleaning action

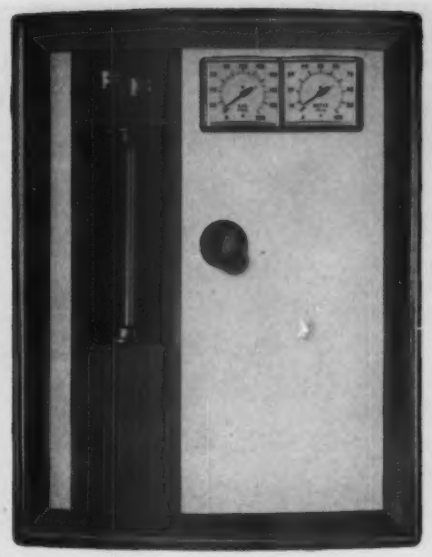
A Newport News rake *won't ride over trash* nor will its teeth drop the debris, because the rake operates in channel guides for positive action. Special teeth are available for cleaning racks of filamentous algae, seaweed, etc.

The Newport News mechanical rack rake has been built to operate in bays from 5 feet 6 inches wide to 28 feet 6 inches in width. Forebay design determines the maximum width for a single rake. In the case of a very wide bay, intermediate guides are sometimes used to reduce the length of the rake. There are many typical installation arrangements to fit your needs. Newport News engineers are prepared to individualize these designs for you.

If you have a debris problem, write for a copy of THE NEWPORT NEWS MECHANICAL RACK RAKE, an illustrated booklet describing the installation, operation, and advantages of a Newport News rake.

Engineers . . . Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News
Shipbuilding and Dry Dock Company
Newport News, Virginia



This, believe it or not, is a wall mounted chlorinator. Its attractive appearance is our way of showing how proud we are of the advanced operating parts hidden behind the front panel. For example: This is the first wall mounted chlorinator ever to feature a single stack regulator. Simple, compact appearance belies the fact that it can handle up to 200 pounds per day of chlorine more accurately, dependably, and safely than any other chlorinator with the single exception of its big brothers. It is so completely corrosion-proof in the right places that we have little hope of ever selling replacement units. In short, we have never been happier with any product than we are with the new Series 3600 chlorinators.

Should you wish to order one of these beauties sight-unseen, on our say-so, we can deliver immediately from warehouse stocks across the country. If not, your local F&P field office will gladly demonstrate the 3600 Series at your plant, at your convenience. Call for an appointment. Or, write for complete information in Bulletin 70C3600. Fischer & Porter Company, 141 Fischer Road, Warminster, Pa.

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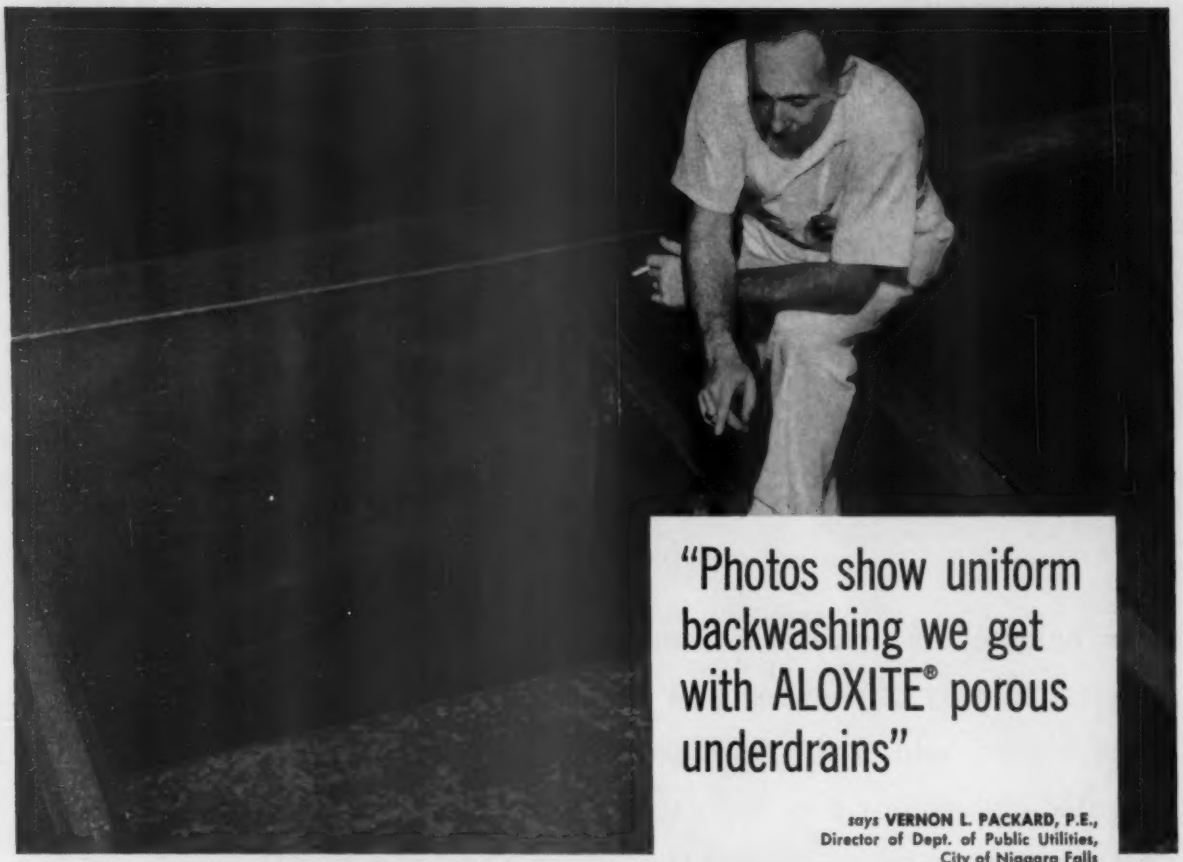
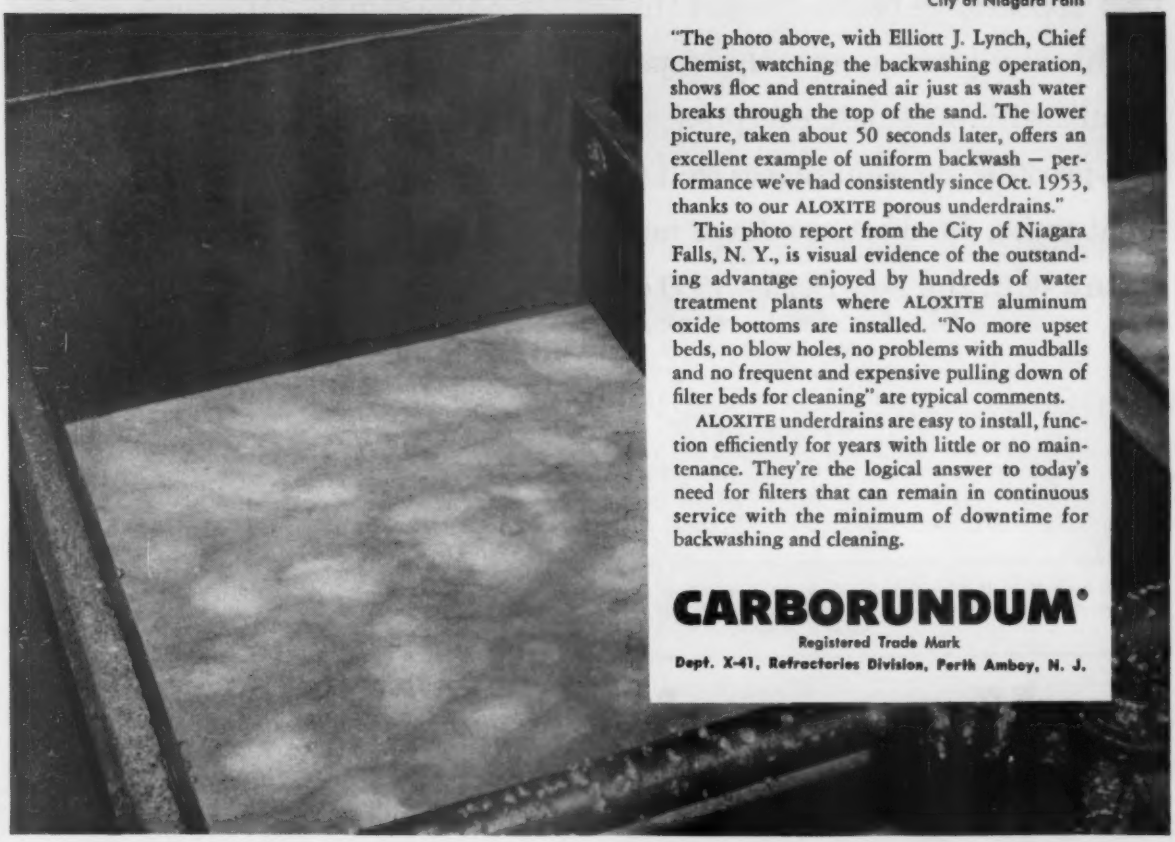
These MANUFACTURING AFFILIATES carry Fischer & Porter engineering designs to the far corners of the earth: FISCHER & PORTER (CANADA) LTD., DOWNSVIEW, ONTARIO • FISCHER & PORTER LTD., WORKINGTON CUMBERLAND, ENGLAND • FISCHER & PORTER G.m.b.H., GROSSELLERSHAUSEN, BEI GOTTINGEN, GERMANY • FISCHER & PORTER N.V., KOMEETWEG 11, THE HAGUE, NETHERLANDS • FISCHER & PORTER Pty. LTD., 184 HANNA ST., SOUTH MELBOURNE, VICTORIA, AUSTRALIA.



"Photos show uniform backwashing we get with ALOXITE® porous underdrains"

says **VERNON L. PACKARD, P.E.,**
Director of Dept. of Public Utilities,
City of Niagara Falls



"The photo above, with Elliott J. Lynch, Chief Chemist, watching the backwashing operation, shows floc and entrained air just as wash water breaks through the top of the sand. The lower picture, taken about 50 seconds later, offers an excellent example of uniform backwash — performance we've had consistently since Oct. 1953, thanks to our ALOXITE porous underdrains."

This photo report from the City of Niagara Falls, N. Y., is visual evidence of the outstanding advantage enjoyed by hundreds of water treatment plants where ALOXITE aluminum oxide bottoms are installed. "No more upset beds, no blow holes, no problems with mudballs and no frequent and expensive pulling down of filter beds for cleaning" are typical comments.

ALOXITE underdrains are easy to install, function efficiently for years with little or no maintenance. They're the logical answer to today's need for filters that can remain in continuous service with the minimum of downtime for backwashing and cleaning.

CARBORUNDUM®
Registered Trade Mark
Dept. X-41, Refractories Division, Perth Amboy, N. J.

IOWA Valves and Hydrants

by the carload to meet San Jose Water Works' growing requirements

Glimpse of new subdivision of San Jose, California. City has grown from 95,280 to 202,571 in past ten years.

Unloading scene as IOWA hydrants are delivered by the carload to San Jose Water Works.

Two IOWA gate valves and a new hydrant being installed. Hundreds of these Iowa products are important components of San Jose's modern system.

Carloads of IOWA gate valves and hydrants were purchased by the San Jose Water Works (an investor-owned, private company established in 1866) for installation in their rapidly expanding system which serves seven cities and unincorporated areas in Santa Clara County, California.

Over 17,000 new water service connections were made in the last two years along 1200 miles of water mains to help care for a metropolitan population (Approx. 306,000) which has doubled since 1950.

IOWA products were selected to be a part of the San Jose Water Works' growth because of their proved dependability with minimum maintenance and assurance of long-life performance.

Every year more and more IOWA valves and hydrants are installed to serve the needs of growing communities like San Jose. Experience shows that IOWA products have that extra quality of materials, that extra-precise fitting and assembly that makes for longer life and easier maintenance.

Let us send you details on the complete IOWA line

IOWA VALVE COMPANY
Oskaloosa, Iowa
Subsidiary of James B. Clow & Sons, Inc.

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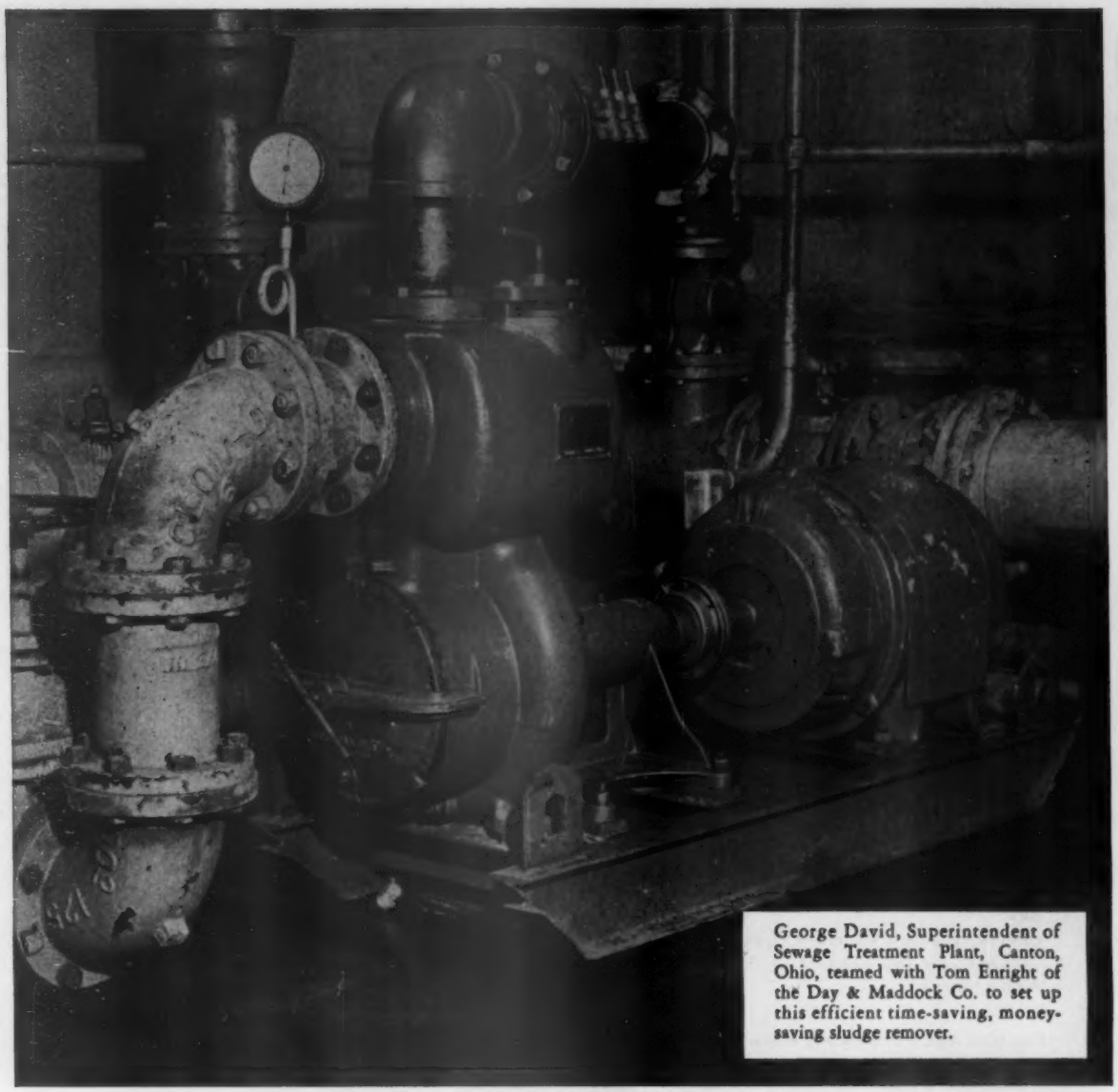

George David, Superintendent of Sewage Treatment Plant, Canton, Ohio, teamed with Tom Enright of the Day & Maddock Co. to set up this efficient time-saving, money-saving sludge remover.

RECIRCULATION AND CLEANING PUMP SOLVES CANTON DIGESTER PROBLEM Gorman-Rupp Sewage Pump cleans with no downtime and major savings

Problem—To remove 7-years' accumulation of sludge from 10 huge digesters. With mechanical shoveling devices, it cost $5000 to clean only one digester. And during cleaning, digester was totally inoperative for 6 weeks.

Answer—A Gorman-Rupp Model 16A2-B Pump. Its unique action first agitates sludge into a common mixture by circulating digester liquid under pressure. Then, with valves reversed, pump draws off liquid and suspended solids for disposal.

Result—Each digester could be cleaned in only 21 days. Only outlay is cost of 6″ pump, electric motor, and labor of opening and closing 2 valves twice a day.

4″ and 6″ pumps can be connected to your power or ordered complete with power units. Write for complete specifications.

Fast-Action End Plate. Releases for access to impeller and renewable wear plate. Impeller is 2-vane trash type that handles spherical solids up to 2½″ in diameter.

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305 Bowman Street • Mansfield, Ohio
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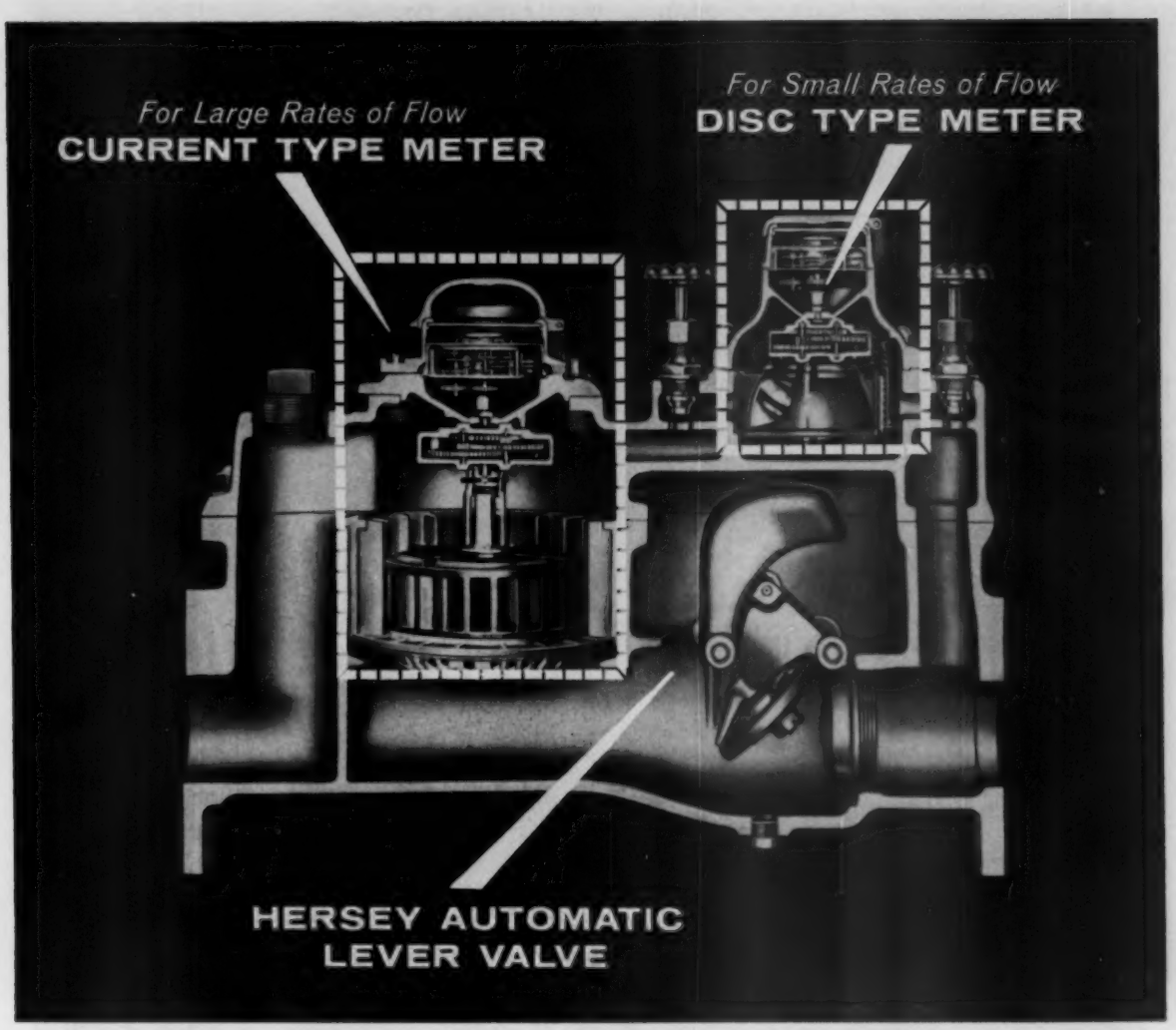
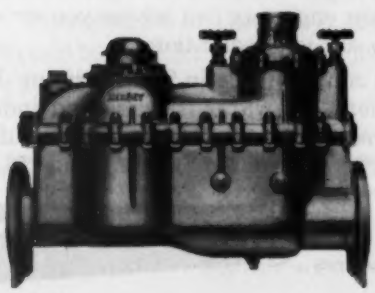


IN ONE BRONZE CASING – A device that accurately measures a larger range of flows than can be measured by any single meter – the incomparable

HERSEY

Compound Meter (Model CT)



Bronze case: 2″, 3″, 4″, 6″ sizes

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HERSEY PRODUCTS
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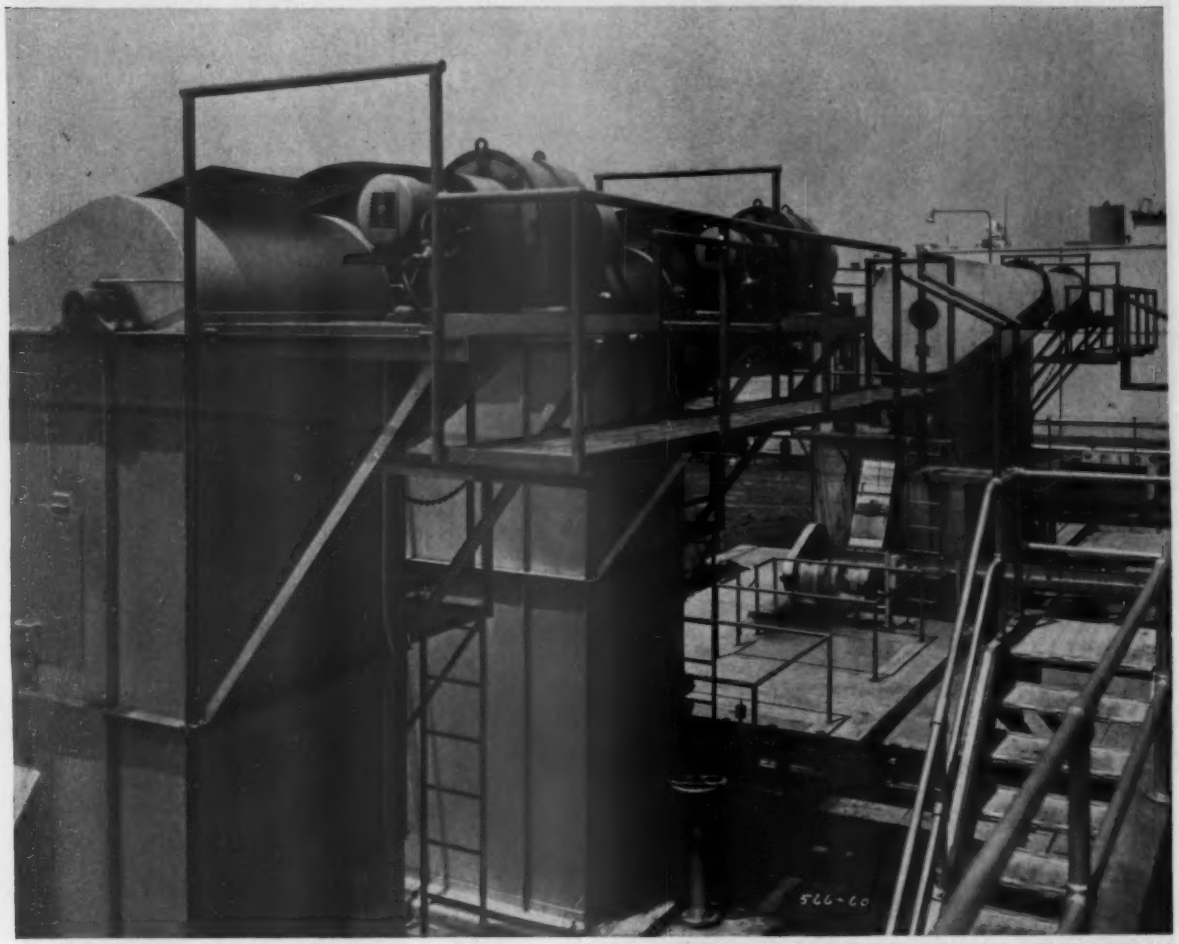
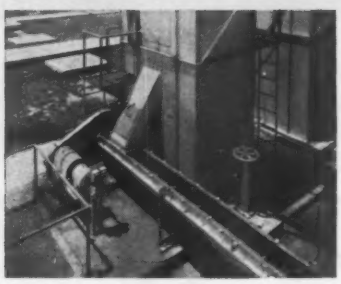
At District of Columbia's Sewage Treatment Plant...



Designed by Metcalf & Eddy, Consulting Engineers.



4 JEFFREY Heavy Duty V-Bucket Collectors dispose of 120 cubic feet of grit per hour

V-buckets, traveling through the aerated grit channels, pick up the grit. At the influent end of the channel, the grit is elevated and the buckets are discharged as they pass over the head sprocket; the buckets are perforated to allow the free water to drain back into the channel. Grit falls into the spiral cross-conveyor, which carries it to the storage area.

Jeffrey supplies grit collectors to suit any local conditions; the scraper type, the elevator-spiral type or the V-bucket type shown here. Type and size are determined by the amounts of grit and flows expected, space available for equipment, and the organic matter encountered. Jeffrey sanitation engineers can advise you on equipment to suit your conditions.

For a copy of Bulletin 952 describing Jeffrey equipment for water, sewage and industrial waste treatment, write The Jeffrey Manufacturing Co., 996 N. Fourth St., Columbus 16, Ohio.

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TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

JEFFREY

ON GUARD IN INDEPENDENCE SQUARE

About 75 feet away from Independence Hall, in the park to the south, stand R. D. Wood Hydrants like sentinels on duty. While their proximity to the Nation's most revered historic monument does not necessarily imply endorsement, we nevertheless like to think of them there, on guard night and day against the fire that could destroy what Gen. Howe saw fit to spare, and Clinton too, in the British occupation. But R. D. Wood Hydrants need no endorsement. For over a century they have shown themselves to be in constant readiness for any emergency. Of simple, ingenious design and rugged construction, R. D. Wood Hydrants are protected against ice and sediment—function smoothly when the engines arrive. There could be no better protection for any community than R. D. Wood Hydrants—and there could be no better protection for the birthplace of the U.S.A.

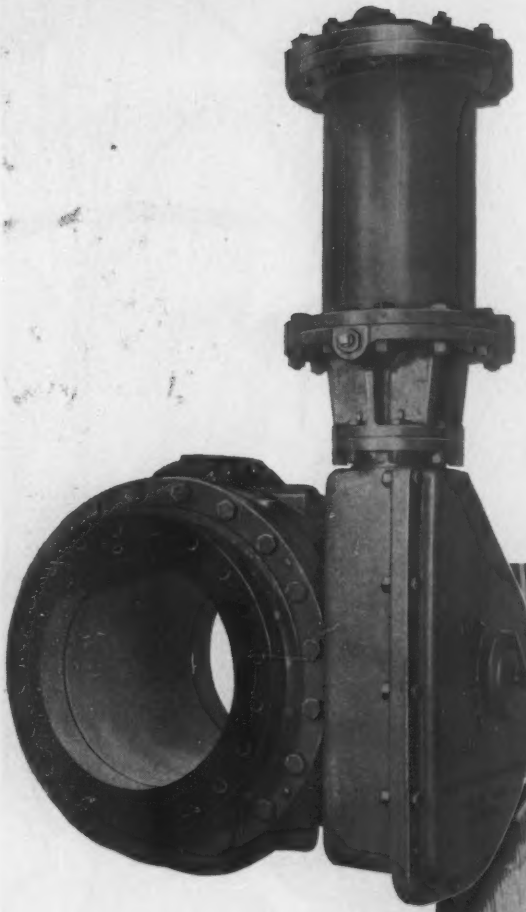
Conform to A.W.W.A. specifications

R. D. WOOD COMPANY

Established in 1803

Public Ledger Bldg.
Independence Square
Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds)



Willamette LIST 26 BALL VALVES

In Kansas City, Missouri, every drop of treated water passes through Willamette Ball Valves in pump check service. Shown above are 5 of 15 Willamette List 26 Ball Valves in automatic pump stop and check service at Secondary Pumping Station. Elsewhere in the system, there are over 120 Willamette Ball Valves in service, including 116 in the distribution grid, in sizes 10" to 42".

Preferred for automatic pump stop and check service, pressure regulating, and strategically located shut-off applications. At present, Willamette Ball Valves are in service in over one hundred cities throughout the country.

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2800 N.W. FRONT AVENUE • PORTLAND 10, OREGON
VALVE DIVISION

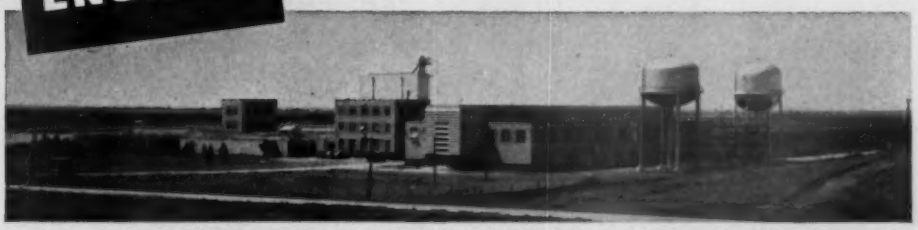
Willamette VALVES ®

ROILINE ENGINES

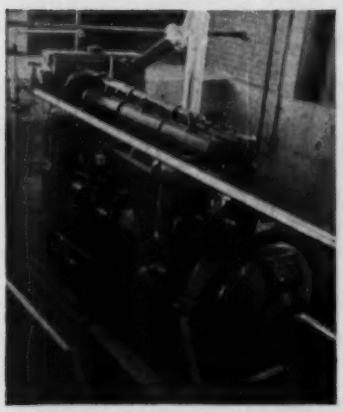
WAUKESHA MOTOR COMPANY

WAUKESHA, WIS. • New York • Tulsa • Huntington Park, Calif.

Factories at Waukesha, Wisconsin and Clinton, Iowa



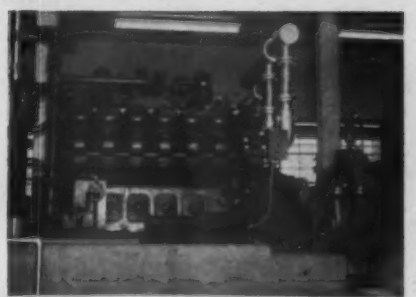
Three ROILINES pull the pumps at Oklahoma City's Lake Hefner Municipal Filtration Plant.



POWER FOR MUNICIPAL PLANTS

Model F-1500, max. hp 215 at 1200 rpm on natural gas.

Model L-3460, max. hp 592 at 1350 rpm on natural gas.



GASOLINE OR NATURAL GAS					600	800	1000	1200	1400	1600	1800	2000	2200	2400
MODEL	Bore & S.	Cyls.	Displ.	Torque–rpm	BRAKE HORSEPOWER AT ENGINE SPEEDS INDICATED									
H570	4⅛ x 4¼	8	570	509-1600	...	71	92	113	134	155	174	190	205	218
H884	5⅛ x 4⅛	8	884	777-1600	...	114	144	175	206	237	267	293	312	324
F1500	6¾ x 7	6	1503	1090- 600	125	165	200	215						
H2000	6¾ x 7	8	2004	1490- 650	170	225	270	290						
L3000	6¼ x 7	12	3006	2200- 700	250	335	405	435						
L3460	7¼ x 7	12	3468	2500- 900	285	380	474	555	592 @ 1350 RPM					
L4000	7.54 x 7.5	12	4000	3020- 600	345	447	550	635						

Horsepower shown is maximum with oil pumps, water pumps, magnetos, air cleaners, carburetors, and exhaust mufflers.

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ARIZONA, Casa Grande, Engine Service Company, Inc.
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404-R2

NEW F-M

NON CLOG SUBMERSIBLE PUMPS

Now! A sewage pump that's not only **non-clogging**—but so easy to install, you actually just "plug it in!" This flexibility plus the non-clogging feature gives you a pump that keeps ahead of any waste removal emergency! Our new, NON-CLOG SUBMERSIBLES are compact, sturdy, and rigidly designed to **stand firm!** And—they can't flood out, under any condition! F-M NON-CLOG SUBMERSIBLE PUMPS are available in 2, 3, and 4-inch sizes—with motors from ¼ HP to 7½ HP. They're your best buy... by far!

HANDLES HEAVY SLUDGE, SLURRIES: Patented, non-clog impeller permits passing liquids containing solids many times the size conventional pumps handle.

EASILY INSTALLED, MOVED: Simple design and installation permits submerged "hook-ups" quickly, easily. Needs only one water-tight plug-in, one pipe.

VERSATILE APPLICATION: Any industrial waste removal system can be expanded, made more flexible! Ideal for storm water drainage, small sewer lift stations—**any** installation using submersible pumping!

Fairbanks Morse makes NON-CLOG PUMPS in a wide variety of frame combinations and sizes: Biltogether, Vertical Close-Coupled, Gear or Motor Driven, Open and Flexible Shaft Drives for dry pit service, with Open or Bladeless Impellers. For further information on a NON-CLOG PUMP designed specifically for **your** installation, write: **Pump & Hydraulic Division; Fairbanks, Morse & Co.; Kansas City, Kansas.**

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A MAJOR INDUSTRIAL COMPONENT OF

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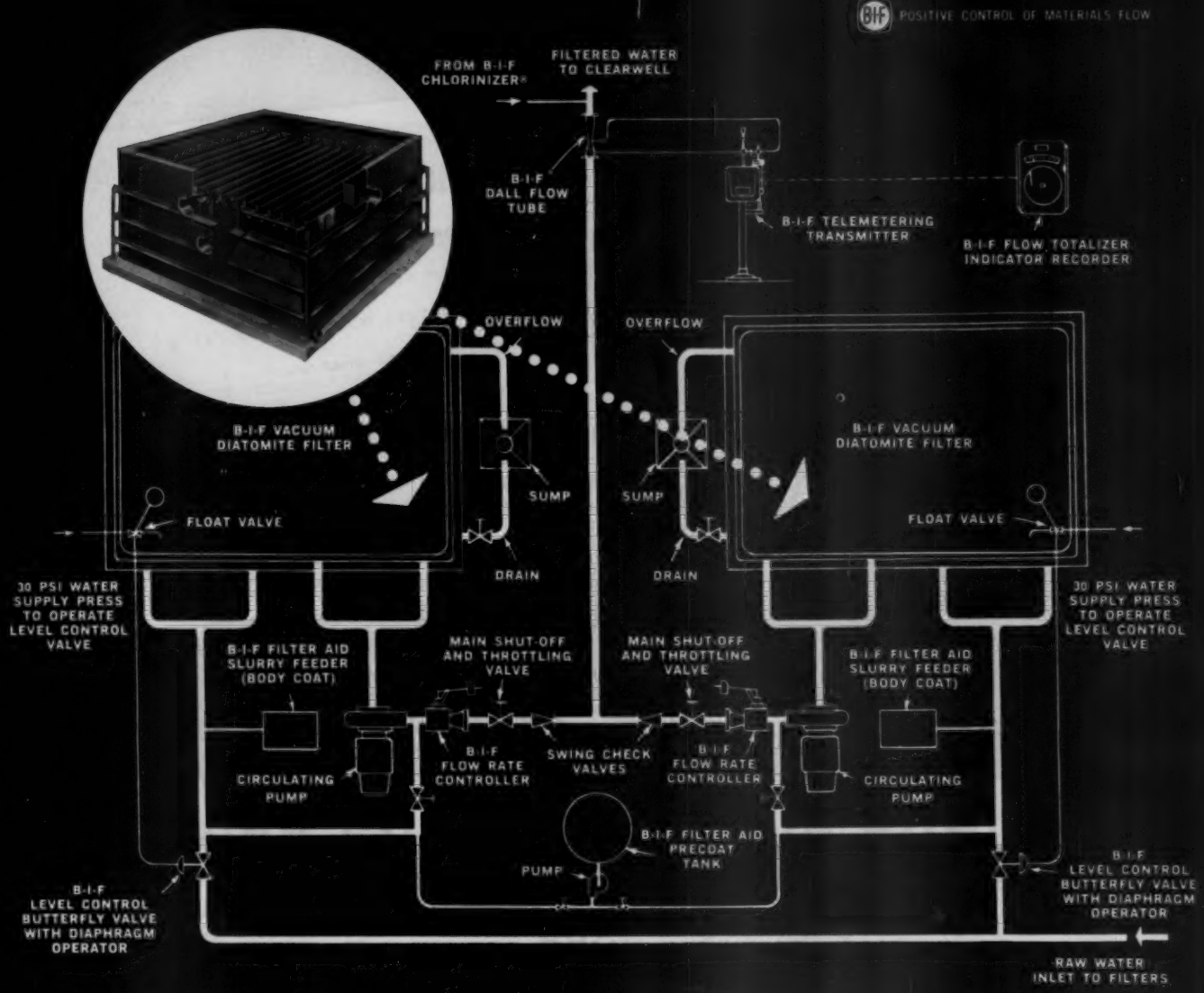
B·I·F POSITIVE CONTROL OF MATERIALS FLOW
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FLOAT VALVE
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30 PSI WATER SUPPLY PRESS TO OPERATE LEVEL CONTROL VALVE
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B-I-F LEVEL CONTROL BUTTERFLY VALVE WITH DIAPHRAGM OPERATOR
RAW WATER INLET TO FILTERS

New **B-I-F** *low cost filtration system meets peak load demands!*

You no longer need high cost expansion to meet peak load demands. At a fraction of the cost formerly required, B-I-F can provide a completely integrated filtration and treatment system. The low installation, operational and maintenance costs save thousands of taxpayers' dollars.

This B-I-F system is built around low cost, performance proven Vacuum Diatomite Filters. The filters' open tank design permits simple visual operation . . . and easier inspection and accessibility. Fiberglass construction eliminates annual painting and repair of protective linings. Chemical pre-treatment is simplified. Wash water requirements are minimized.

From its line of compatible components . . . filters, chemical feeders, instrumentation, butterfly valves, etc. . . . B-I-F will provide a coordinated system to meet your specific peak load requirement. A B-I-F system requires minimum start-up time . . . assures maximum reliability, flexibility for further expansion, and dependable, single responsibility.

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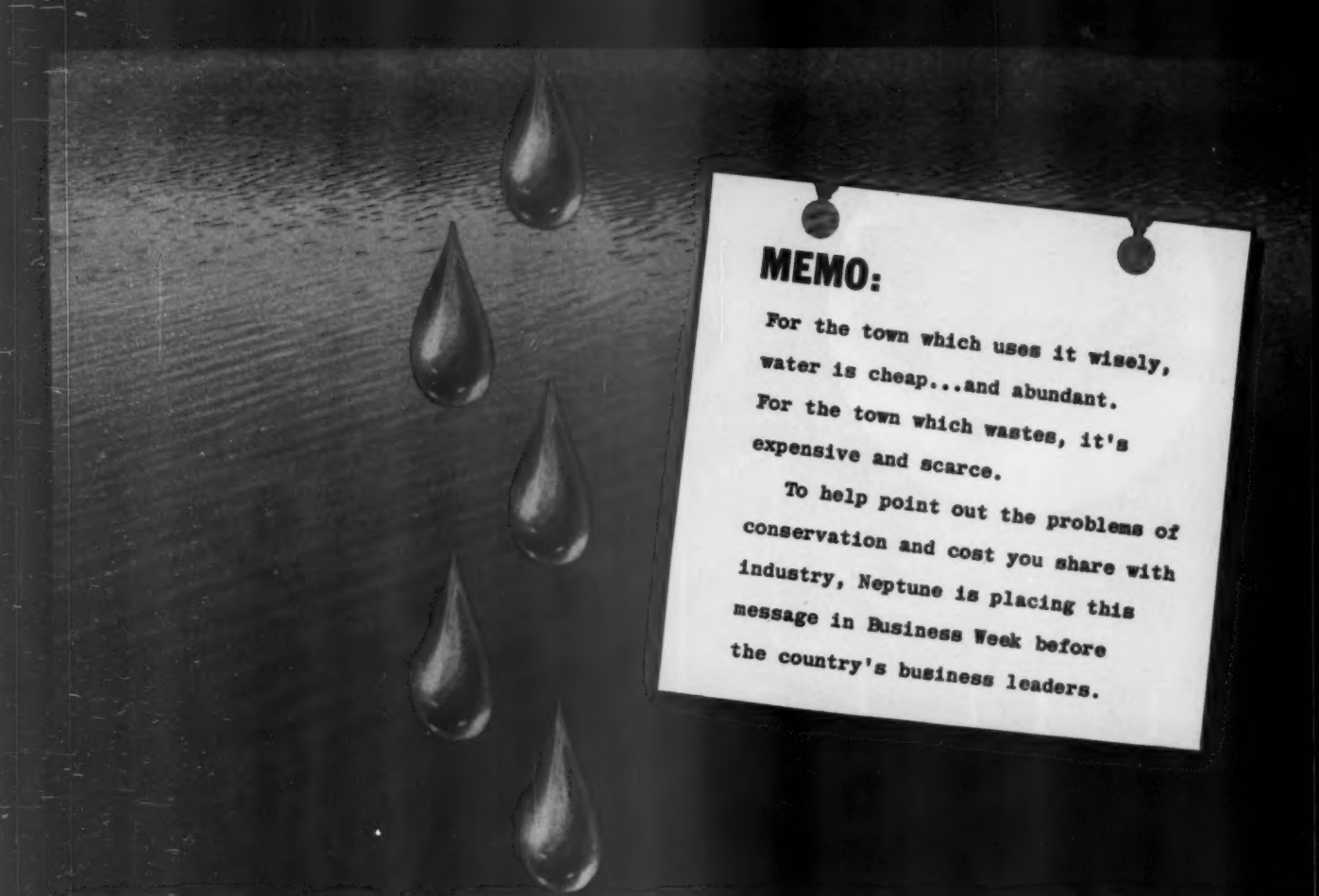
MEMO:
For the town which uses it wisely, water is cheap...and abundant. For the town which wastes, it's expensive and scarce.
To help point out the problems of conservation and cost you share with industry, Neptune is placing this message in Business Week before the country's business leaders.

WATER IS A MANUFACTURED PRODUCT

...too expensive to waste

Here's what Ansco Mfg. Co. gets out of a gallon of water (with the help of Neptune meters)

1. Well water at 53° used first for air conditioning
2. Chlorinated, used for spray washing
3. Used in chemical dehumidifier
4. Passes through heat exchanger
5. Passes through ammonia condenser
6. Goes to fire protection reservoir
7. Finally used to cool roof

Water in the lakes and rivers is free, but there it's only a *raw* material.

Before you can use it, you put it through a complete chemical manufacturing process. You need expensive equipment and chemicals to collect it, store it, pipe it and purify it. By that time water is much too expensive to waste.

But how do you keep your people from wasting it?

Install water meters at every key point in your plant. Measure what every department or process uses. Ask the meters to uncover hidden leaks and careless habits. They show where you can save with automatic shut-off devices, by improving heat exchangers, by altering processes, by recirculating and reconditioning water for re-use. Don't dump a drop down the drain until you've gotten full use out of it.

Call Neptune for help in saving water costs. Though Neptune now means more than just meters, water conservation—through accurate metering—is still our biggest business.

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LIQUID METERS
GAS METERS
ELECTRONIC SYSTEMS and COMPONENTS for MEASUREMENT and CONTROL

Vol. 108, No. 4 • April 1961
WATER & SEWAGE WORKS
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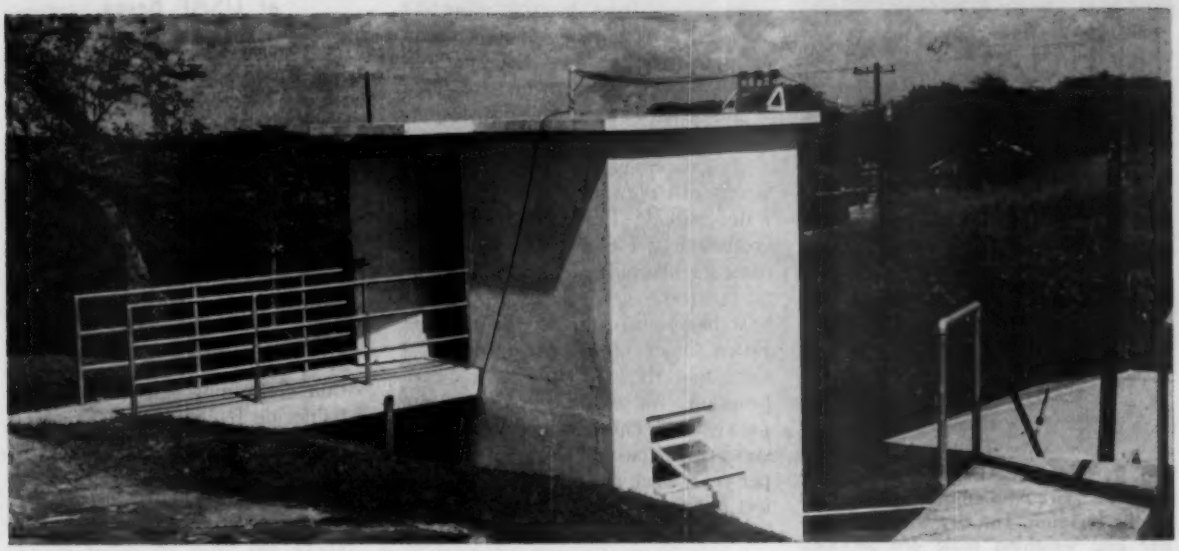

Structure housing fluoride feeders at Clark AFB, Philippines is typical of those established under

USAF'S Water Fluoridation Policy

by FRANCIS A. SANDERS, Lt. Col., USAF,
Chief of Operations Division,
USAF Ohio River Civil Engr. Region,
Cincinnati 6, Ohio

EDITOR'S NOTE: This article reports on the status requirements for, and the policy establishing the practice of fluoridation of water supplies on United States Air Force Bases. Since fluoridation is directed at children's improved dental health, the requirement for fluoridation depends on the number of housing units served.

■ FLUORIDATION of potable waters supplies for United States Air Force (USAF) installations was approved in principle nearly ten years ago. However, until the last two or three years, very little fluoride treatment of water was being accomplished. Recently, the Air Force Surgeon General's Office took a positive approach which required all Air Force Bases to evaluate their fluoride treatment requirements, and directed each to request authority to treat water with fluoride where applicable. This approach stimulated considerable action, but actual progress has not been quite as rapid as it could be. There is a reason for this lag and also reason for a feeling of satisfaction through accomplishments to date.

Status of Fluoridation

The USAF and the other Armed Services are in an enviable position in regard to being able to institute fluoride treatment without the problem that confronts a number of communities. There has been no opposition to fluoridation in the USAF worthy of note. In fact of all of the bases where fluoridation is being practiced, there has not been a single instance where an occupant of a home has adversely criticized the use of fluoride treatment. The personnel responsible for the approval and installation of fluoride treatment believe that fluoridation has been tested sufficiently long to prove its beneficial effects and that it can be safely controlled. These men respect the professional judgment of the federal and private organizations who have endorsed and recommended its use: the American Medical Assoc.; the American Dental Assoc.; the Public Health Service; the American Water Works Assoc. and the Office of the Surgeon General, USAF.

With this background it might appear that fluoridation is practiced at all USAF bases. It is not as simple as that. Probably the greatest hindrance to providing Air Force-wide fluoridation has been the lack of funds, coupled with the lack of realization by Base Commanders and others, of the benefits to be derived. With limited funds to perform his operational mission, a Base Commander may decide that it is more urgent to fund the op-

Fig. 1. CHEMICAL FEEDING equipment at Clark AFB employs both floors of the building. The dry chemical hopper and weighing scale are serviced on the upper floor. The feeder, control and pump shown here are on the lower floor.

erational mission requirement than it is to expand the funds necessary to provide fluoride treatment. It is the writer's opinion that if commanders who have not provided fluoride treatment had a better understanding of the benefits derived, they would consider the need for fluoridation more worthy and urgent than some of the funded operational requirements.

Fig. 2. INSTALLATION at Chanute AFB, Ill. using fluosilic acid and positive pump feeder. Pump is supported on wall and acid containers are in lower foreground.

Need for Fluoridation

The best reason for fluoride treatment is that it has been shown to reduce dental decay by approximately 50 per cent. Another sound reason for fluoridation in the USAF is illustrated by cost figures. These figures would be partly indicative of the money spent or saved by the citizens of a civilian community depending on whether or not they had a fluoridated water supply. The following figures are based on the cost to the Government for manning and providing dental facilities.

It has been estimated by the Air Force Office of Dependent Medical Care that the cost of a dental care program for Military dependents (wives and children of all military servicemen) would cost $52 million per year. Such a program is not in effect but there is hope that action will be taken by Congress in the next year or two to authorize Dependents Dental Care. Of this total, approximately $29 million would be paid by the Government. The balance, $23 million, would be paid by Military families. Considering a reduction of tooth decay in children by 50 per cent it can be readily seen that fluoride treatment could save Military families and the Government millions of dollars by reducing the cost of the Dental Care program, if and when it is approved.

It is only in the past two or three years that fluoride treatment has been of such great potential value in the USAF. Since Congress passed the Capehart Housing Act, thousands of families are now living on Air Force Bases. As of Jan. 1960, the USAF owns, has planned or has under construction 157,708 houses. In addition, USAF families live in 9,118 houses owned by others which for the most part are supplied water from Air Force Bases. Assuming an average of 1.5 children per family, there will be approximately 255,000 children involved when housing construction is completed. The present fluoride treatment program is not in phase with this rapid housing development although it is making great strides to get in phase.

Approximately 200 Air Force Bases have enough houses to make fluoride treatment practical. Some of these have enough natural fluoride in their water supply and some are receiving fluoridated water from off-base sources. The largest number of housing units on any one Air Force Base at the present time is 2397. The water supply of this particular base contains 1.2 mg/L of natural fluoride. It needs none added.

Table 1 shows various related information concerning Air Force Bases and fluoride requirements. The most significant fact from this table is that of 125 Air Bases where fluoridation would be practical, only 53 bases are presently served.

There has been no effort to add fluorides to water supplies contain-

Table 1

Fluoridation of Water Supplies at USAF Bases

Description of Water Supplies	Number of Bases
Practical but not practiced	125
Practiced	53
Natural levels of 0.5 mg/L or more	45
Received from Off-base sources	18
Impractical to treat	40

Table 2

Summary of Information Collected from a Survey of 47 USAF Bases Practicing Fluoridation

Item	Detail	Reported
Housing Units	Least per base	204
	Average	1008
	Maximum	2137
Volume of Water Treated	Minimum per base	0.1 mgd
	Average	1.3
	Maximum	3.0
Fluoride Content before Treatment	Lowest	0.0 mg/L
	Average	0.1
	Highest	0.4
Fluoride Content after Treatment	Lowest	0.6 mg/L
	Average	1.0
	Highest	1.2
Type Chemical Used	Sodium Fluoride	24
	Sodium Silicofluoride	14
	Fluosilic Acid	9
Method of Analysis	Color Comparison kits	45
	Spectrophotometer	1
	Megregian	
	Maier Method	3*
Frequency of Analyses	Least	1 per wk.
	Average	1-2 per day
	Most	2-hr. intervals
Cost of Facilities	Lowest	$ 800
	Average	5,700
	Largest	22,640
	Average per source	2,900

* Two bases use both methods

ing as much as 0.5 mg/L. In fact, several of the bases have a problem of too much fluoride. One base has installed equipment to remove excess fluoride from the water supply and others are investigating this problem.

Eighteen Air Force Bases obtain water from nearby communities or nearby Military Bases which are already adding fluoride to the water supply. For example, Hickman Air Force Base is supplied fluoridated water by the Pearl Harbor Naval Station in Hawaii.

Forty bases have water supplies which are considered impractical for fluoride treatment installation because of the multiple water sources combined with scattered location of houses, temporary nature of the bases, or other reasons.

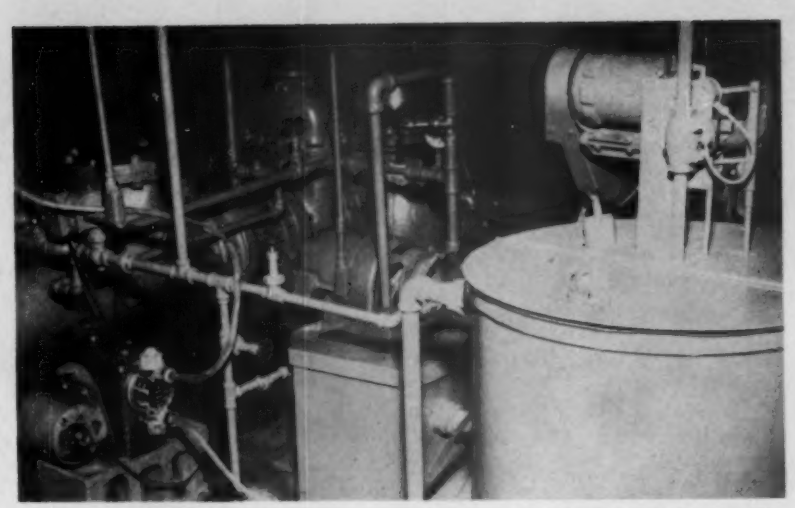

Fig. 3. FLOURIDE FACILITY in one well house at Shaw AFB, S. C. The saturation tank containing granular sodium fluoride is at right. Chemical feed pump is on the left.

Methods for Adding Fluorides

A survey of 53 bases using fluoride treatment provided information on 47 of them. Fig. 2 shows a simple arrangement used at Chanute Air Force Base, Ill. utilizing fluosilic acid and a positive pump feeder. Two such installations are located at Chanute AFB to treat the average 1.5 mgd water demand. The total cost of both installations including testing equipment was $1750. Nine Air Force Bases have chosen fluosilic acid as the fluoridation chemical.

Fig. 3 shows one of four similar installations at Shaw AFB, South Carolina, using granular sodium fluoride to treat approximately 1.75 mgd. The total cost for these installations at four wells was $3265. Twenty-four bases have chosen sodium fluoride as the chemical.

Fig. 4 is a view of the equipment used at Schilling AFB, Kansas to feed sodium silicofluoride (powdered form). The cost of this facility including the fluoridizing unit, controls, construction of a chemical storage room and laboratory equipment was $5,784. Sodium silicofluoride is being used at 14 Air Force Bases.

The cost figures in Table 2 warrant special mention, because they cover a wide range. For instance, the most expensive facility cost $22,640 to install 10 chemical feeders with auxiliary equipment. The next most expensive installation is $22,000 to install one chemical feeder with auxiliary equipment and a building to inclose it. A few of the facility costs appear to be abnormally high and some include the construction of buildings which are used jointly for chlorination or other facilities. Information is not available to separate actual costs. Some of the facilities are rather lavish whereas others are simple but adequate and installed in a very few square feet of existing space. The average cost for each base is $5700. Facility costs at forty-two of the forty-seven bases average approximately $4000. Twenty-one of the bases have multiple water sources usually requiring flouride treatment at the various sources. The average cost of fluoridation facilities per water source, such as per well supply, is $2900. Practically all of these facilities were accomplished by contract and with technical guidance of equipment manufacturers.

Fig. 4. FLUORIDE EQUIPMENT at Schilling AFB, Kansas feeds silicofluoride. Flow recorder is in the foreground. The tall compartment is designed to minimize dispersal of the fine powder in the room, when dry chemical is charged to the feeder.

Planning

The future planning calls for rapid fluoridation expansion in the USAF. More information pertaining to fluoridation is being disseminated from higher command to lower echelons. A new Air Force Civil Engineer magazine, published in February, 1960, emphasizes fluoridation in an article which is aimed at increasing the use of fluoridation. A new USAF Headquarters criteria has recently made fluoridation, where needed, a standard part of the utilities to be provided in the future construction of family houses. Twenty-two of the fifty-three Air Force Bases having fluoride treatment, installed the equipment as recently as last year. A number of other bases have already obtained the necessary approval for fluoridation while others are in the actual stages of design or installation at the present time. The optimistic outlook calls for essentially all bases in the USAF, where practical, to practice fluoridation of water supplies, and to do so within the next

A Nomograph for the

Selection of Pipe Classes

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EDITOR'S NOTE: The nomograph developed here was drawn up to facilitate determination of pipe classes for conduits subjected to simultaneous internal pressure and external load.

■ A NOMOGRAPH has been drawn up in order to facilitate the determination of pipe classes for conduits subjected to simultaneous internal pressure and external load. The nomograph (Fig. 4) is based on determination of loads by Marston's[1] and Spangler's[2] theories and on the relationship between internal pressures and external loads already established for various types of pipe.

The combination of pressures and loads both within and without the pipe is further complicated by numerous factors affecting the external load and the equivalent three-edge bearing load.

In the nomograph there are two correlated parts. The right-hand side gives the load on a pipe in trench or projection condition. The left-hand curves show the relation between internal pressure and external load. Each part may stand by itself. Each part is discussed in turn and then both are considered together as a whole.

Determination of Load on Pipe

The load on pipe is affected by the following factors:

1. H, depth of fill over crown.
2. Breadth (depends on field conditions)
   (a) B_d, width of trench at crown (trench condition).
   (b) B_c, pipe outer diameter (projection condition).
3. Soil properties.
   (a) δ, unit weight of fill material.
   (b) K, ratio of active lateral pressure to the vertical as used in Rankine's formula.
   (c) μ, coefficient of internal friction of fill material.
   (d) μ^1, coefficient fill material and tion between fill material and sides of trench.

According to Marston[1] the earth fill load per linear unit of pipe is:

(a) For trench condition

$$W_d = C_d \, \delta \, B_d^2 \qquad (1a)$$

where

$$C_d = \frac{1 - e^{-2k\mu^1 \frac{H}{B_d}}}{2K\,\mu'} \qquad (2)$$

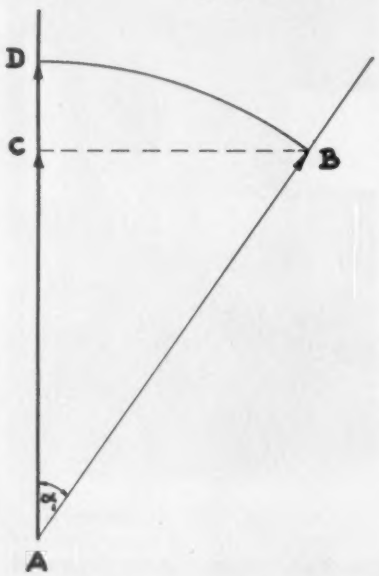

FIG. 1. METHOD of finding earth load on pipe due to change in unit weight of fill.

(b) For projection condition

$$W_c = C_c \, \delta B_c^2 \qquad (3a)$$

where

$$C_c = \frac{e^{2K\mu \frac{H}{B_c}} - 1}{2K\,\mu} \qquad (4)$$

That is,

$$W_d = \delta \, f\,(K\mu', H, B_d) \qquad (1b)$$

$$W_c = \delta \, f\,(K\mu, H, B_c) \qquad (3b)$$

In order to draw the load curves of earth fill on pipe as a function of height of fill above the pipe crown, it is necessary to determine definite values for $K\mu'$, B_d, and δ in the case of trench condition, and for $K\mu$, B_c and δ in the case of projection condition.

A nomograph is prepared which is based on:

1. Computation of the external load on the pipe as a function of the depth of fill over the pipe for complete projection condition, which leads to the maximum loading on the pipe that may possibly occur under any condition.

2. Computation of the external load on the pipe as a function of the depth of fill over the pipe for ditch condition for varying width of trench under soil properties, δ_o, $K_o\mu_o$, and $K_o\mu^1_o$, for a pipe whose outer diameter is B_c.

The construction of the nomograph is as follows:

The horizontal scale shows the depth of the fill over the crown of the pipe.

The vertical scale shows the external load on the pipe per linear unit.

In the event that field conditions establish that the unit weight of the fill material, δ_1, differs from δ_o, for which the nomograph is constructed,

and $K_1\mu'_1 = K_o\mu'_o$, then the load W_{do} obtained from the nomograph must be multiplied by the ratio $\frac{\delta_1}{\delta_o}$ (the load is a linear function of δ).

$$W_{do} = C_{do}\, B_d^2\, \delta_o \qquad (5a)$$

$$W_{d1} = C_{do}\, B_d^2\, \delta_1 = [C_{do}\, B_d^2\, \delta_o]\, \frac{\delta_1}{\delta_o} = W_{do}\, \frac{\delta_1}{\delta_o} \qquad (6a)$$

(C_d is independent of δ).

If the value for δ_o is chosen so that $\delta_o < \delta_1$, then

$$\frac{\delta_1}{\delta_o} = \frac{1}{\cos\alpha_1} = v_1 \qquad (7)$$

and

$$W_{d1} = W_{do}\, v_1 \qquad (6b)$$

This multiplication can be done by the following method (Fig. 1):

If vector $\overline{AC}$ represents load W_{do}, vector $\overline{AB}$ lying on the index line that makes angle α_1 with $\overline{AC}$ equals $\overline{AC}/\cos\alpha_1$. From A as a center, draw arc BD. Then $\overline{AD}$ represents the required load W_{d1}, inasmuch as $\overline{AD} = \overline{AB} = \overline{AC}/\cos\alpha_1$.

Hence, if a system of arcs be drawn, the center of which is the origin of index lines inclined at various angles, the graphical multiplication for various conditions may be performed (Fig. 2).

The problem is further complicated in the event that field conditions establish that the unit weight of the fill material, δ_1, and the coefficient $K_1\ \mu'_1$ differ from δ_o and from $K_o\ \mu'_o$, for which the nomograph is constructed. (The factor $K\mu'$ does not vary linearly.)

$$W_{do} = C_{do}\, B_d^2\, \delta_o \qquad (5a)$$

$$W_{d1} = C_{d1}\, B_d^2\, \delta_1 \qquad (5b)$$

but

$$W_{d1} = W_{do}\, \frac{\delta_1}{\delta_o}\, \frac{C_{d1}}{C_{do}} \qquad (8)$$

and

$$\frac{C_{d1}}{C_{do}} = \frac{2K_o\mu'_o}{2K_1\mu'_1}\, \frac{1-e^{-2K_1\mu'_1 \frac{H}{Bd}}}{1-e^{-2K_o\mu_o \frac{H}{B_d}}} = \eta \qquad (9)$$

Let η be drawn as a function of $\frac{H}{B_d}$ for various values of $K\mu'$ (Fig. 3). The appropriate value of η may be found from this auxiliary nomograph. Then

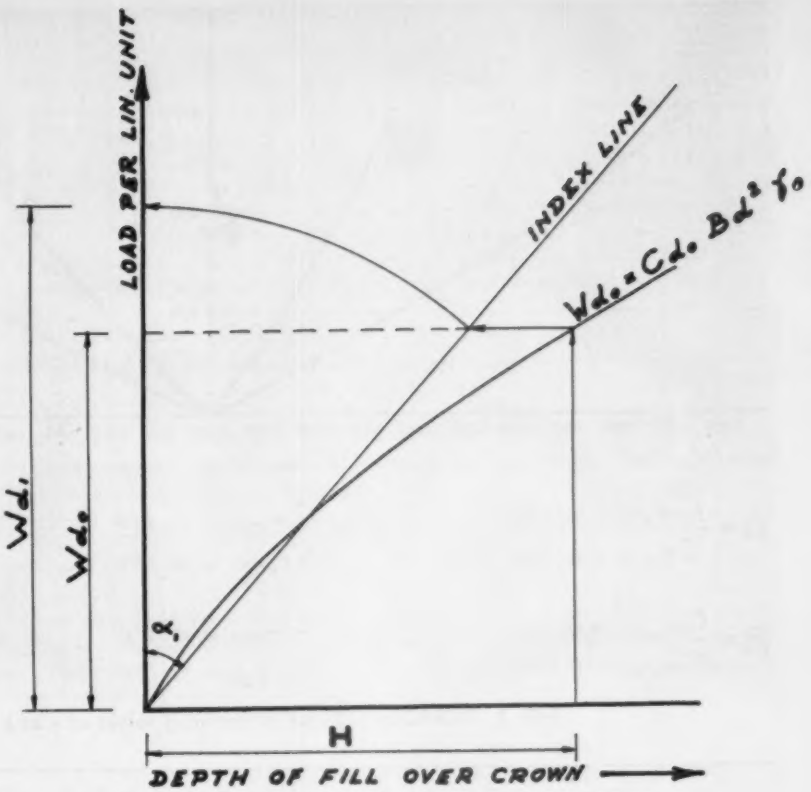

FIG. 2. GRAPICAL multiplication for varied conditions.

$$\frac{\delta_1}{\delta_o}\, \frac{C_{d1}}{C_{do}} = \frac{1}{\cos\alpha_2} = v_2 \qquad (10)$$

$$W_{d1} = W_{do}\, v_2 \qquad (11)$$

The procedure of the graphical multiplication is as before. On consulting the appropriate index line (right, Fig. 4) obtains the same load of fill material over the pipe as that determined by field conditions.

Determination of Relationship Between Internal Pressure and External Load

Taking, for example, prestressed concrete cylinder pipe, the relation between internal pressure and external load may be computed by the formula proposed by Kennison (3):

$$W_1 = W \sqrt[3]{\frac{P_o - P_1}{P_o}} \qquad (12)$$

in which

W_1 = three-edge bearing load at any internal pressure, P;
P_1 = internal pressure at any three-edge bearing load, W;
W = three-edge bearing load at $P_1 = 0$; and
P_o = internal pressure at $w_1 = 0$.

Construction of the nomograph (left, Fig. 4) will be as follows:

The horizontal scale shows the pressure within the pipe.

The vertical scale shows the external load on the pipe per linear unit.

Inasmuch as pipes of equal diameter are designed to different working pressures, the result is a number of curves of similar shape.

As previously stated, the supporting strength of pipe is affected by both its specific strength and its bedding conditions.

The internal pressure—external load curves for a number of pipes, equal in diameter but differing as to working pressures and specific strength, may be constructed for a bedding condition coefficient β_o. The relation between the internal pressure and the external load is

$$W_1^{\circ} = \beta_o\, W \sqrt[3]{\frac{P_o - P_1}{P_o}} \qquad (13)$$

In case the supporting strength must be determined for another bedding factor β_1, the load obtained from the nomograph must be multiplied

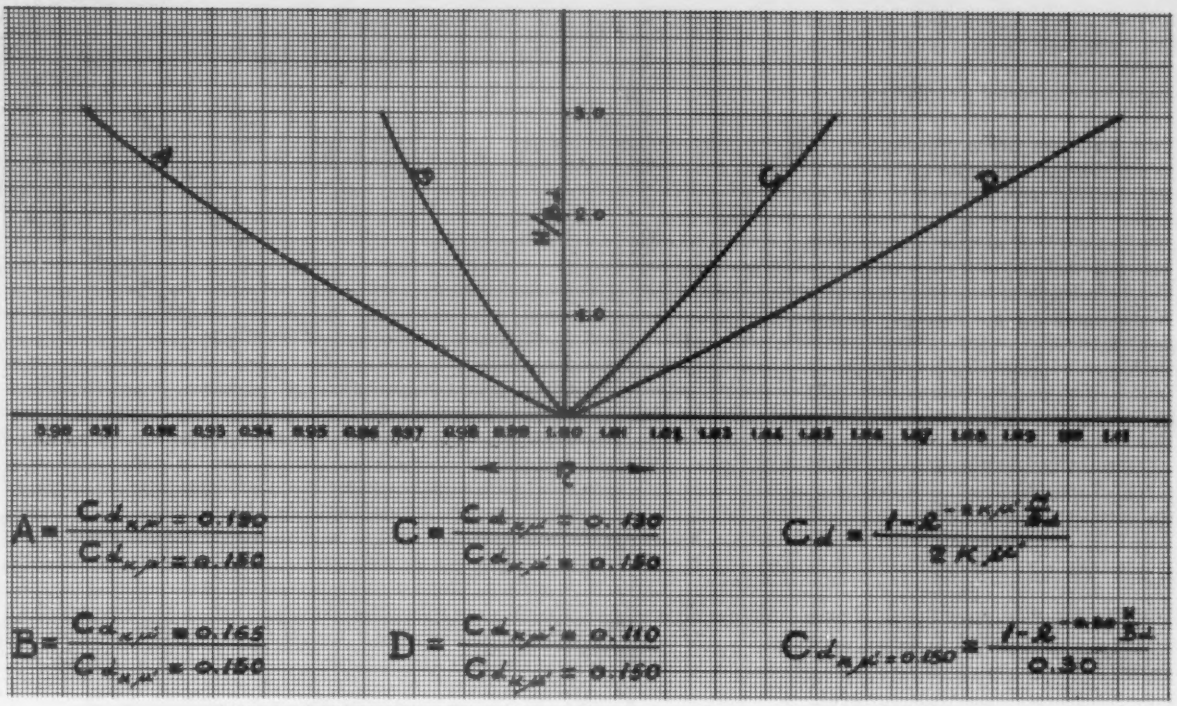

FIG. 3. NOMOGRAPH for determining values of η as a function of H/B_d.

Table I
Typical Solutions of Various Cases

Case No.	Installation Condition	Soil Wt. (pcf)	$K\mu'$ or $K\mu$	B_d or B_c (ft)	H (ft)	P (psi)	Bending Factor	Pipe Class	Solutions
									$\nu = 0.02\frac{\eta\gamma}{\beta}$ $\qquad$ $\beta = \frac{\eta\gamma}{\nu}$
1	Complete projection	100	0.15	7.0	5.5	70	1.1	?	$\nu = \frac{0.02 \times 100}{1.1} = 1.82$ $\qquad$ $\therefore$ Pipe class = 2
2	Ditch	112	0.11	9.0	10.0	80	?	4	$\nu = 1.49$ (from nomograph) $H/B_d = \frac{10.0}{9.0} = 1.11$ $\qquad$ $\therefore \eta = 1.045$ $\therefore \beta = 0.02 \times 1.045 \times \frac{112}{1.49} = 1.57$
3	Ditch	120	0.165	11.0	13.0	?	1.9	7	$H/B_d = \frac{13.0}{11.0} = 1.18$ $\qquad$ $\therefore \eta = 0.984$ $\nu = \frac{0.984 \times 0.02}{1.9} \times 120 = 1.24$ $\therefore P = 93$ psi
4	Ditch	130	0.11	12.0	?	120	1.5	5	$\nu = \frac{0.02 \times 130}{1.5} = 1.73$ Complete projection condition prevails $\therefore H = 6.4$ ft
5	(Find load on the pipe for Case 3)								$\nu = 1.24 \times \frac{1.9}{1.5}$ $\therefore W = 11{,}250 \times \frac{1.9}{1.5} = 14{,}250$ lb

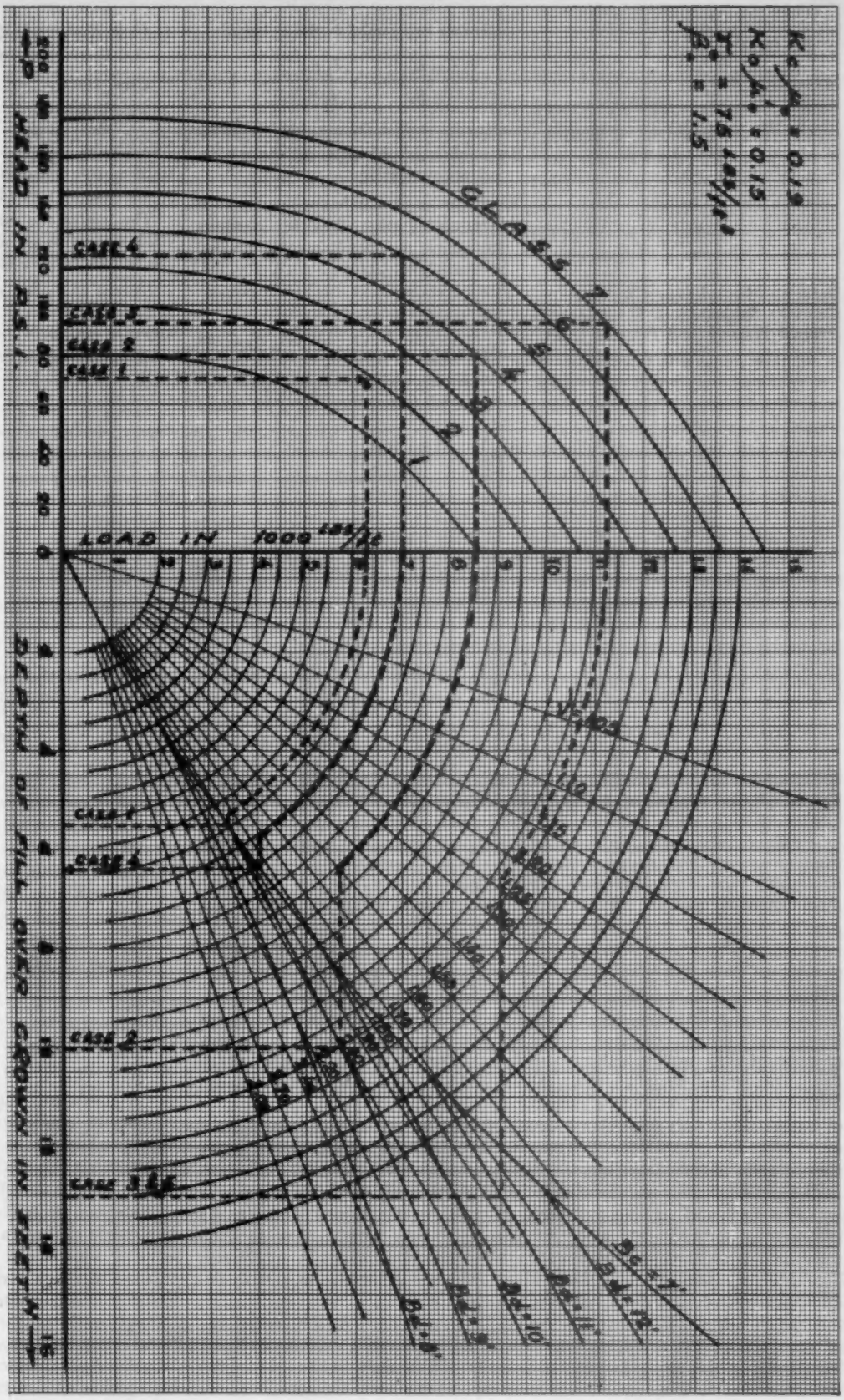

FIG. 4. NOMOGRAPH for a pipe subjected to external load and internal pressure.

by the ratio $\frac{\beta_1}{\beta_o}$. (The load is a linear function of β.)

$$W_1' = W \sqrt[3]{\frac{P_o - P_1}{P_o}} = W_1^o \frac{\beta_1}{\beta_o} \quad (14)$$

$$\frac{\beta_1}{\beta_o} = \frac{1}{\cos \alpha_3} = v_3 \quad (15)$$

Determination of Pipe Class for Conduits Subjected to Simultaneous Internal Pressure and External Load

All that remains is to combine the external load nomograph with the external load—internal pressure nomograph, both of which have a common vertical scale and load axis (Fig. 4).

Let the nomograph be constructed for pipes of outer diameter B_c and for varying widths of trench increasing by steps for δ_0, $K_c\,\mu$, $K_o\mu'_o$ and for bedding factor β_o, and suppose it is required to determine the pipe class which is subjected to other conditions, say δ_1, $K_1\,\mu'_1$, and β_1*. It is necessary to establish the value of

$$\frac{\delta_1 C_{d1} \beta_o}{\delta_o C_{do} \beta_1} = \eta \frac{\delta_1 \beta_o}{\delta_o \beta_1} = v_n \quad (16)$$

in order to find the appropriate index line and then to perform the graphical multiplication.

In order to clarify the operation of determining pipe class for conduits subjected to simultaneous internal pressure and external load, the following example is used with nomenclature as previously stated:

B_c = 7.0 ft, δ_o = 75.0 pcf, $K_o\mu'_o$ = 0.15, $K_c\mu_o$ = 0.19, β_o = 1.5, and B_d = varying width of trench commencing at 8.0 ft and increasing by stages of 1 ft.

Pipe Class	P_o (psi)	W_o (lb/ft)
1	80	5,740
2	100	6,470
3	115	7,140
4	130	7,860
5	145	8,470
6	160	9,070
7	175	9,660

When either H or B_d is unknown and $K_o\mu'_o \neq 0.15$, H/B_d cannot be found immediately, and the solution is arrived at by the method of approximation:

1. Case $K_o\mu'_o = 0.15$ must be solved and thereby the unknown found.
2. Find H/B_d.
3. Find unknown η.
4. Find v_n.*
5. Find the unknown through use of the nomograph (Fig. 4).

The use of the nomograph can be made clear through solution of a number of cases as presented in Table 1.

One of the advantages of the new nomograph is that it can readily show whether pipe load depends on trench width or projection condition.

$$* \frac{\delta_1 C_{d1}}{\delta_o C_{do}} W_{do} = \frac{\beta_1}{\beta_o} W_1^o$$

$$W_1^o = \frac{\delta_1 C_{d1}}{\delta_o C_{do}} \frac{\beta_o}{\beta_1} W_{do}$$

$$*v_n = \frac{\delta_1 \beta_o}{\delta_o \beta_1} \eta = \frac{1.5}{75} \frac{\delta \eta}{\beta_1} \eta = 0.002 \frac{\delta \eta}{\beta_1}$$

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Filter Plant Warmed by Radiant Heating

A unique, two-zone radiant heating installation at Hackensack Water Company's New Milford filteration plant addition, Oradell, N. J., has provided more than four years of uniform warmth and trouble-free operation in the filter operating gallery.

The new addition, with a capacity of 18 million gallons per day, houses 6 rapid-sand filter beds, each with a capacity of 3.25 million gallons per day. The entire plant contains 22 filters that process 60 million gallons of water daily for service to hundreds of thousands of residential, commercial and industrial customers.

The hidden ceiling and floor radiant heating panel installation was fabricated of wrought iron pipe coils embedded in concrete. It radiates its heat load to the centrally located 2,730-square-foot operating gallery, and the resulting heat transfer to the unheated filter area prevents water from freezing during wintertime filteration.

The radiant heating system was designed to handle a 600,000 Btu heat loss. Its two-zoned installation, employing ceiling and floor panels, was necessary to obtain the required capacity within the area available.

The plan was to install the radiant heating in the operating gallery only and rely on heat transfer to the unheated filter area. Neither the area of the floor nor the ceiling in the gallery was sufficient to house a panel which would adequately handle the required heat loss.

Thus, each zone, ceiling and floor, is equipped with its own hot water circulator which operates continuously. A three-way modulating valve is installed in the 2-inch diameter wrought iron supply lines to each zone; the valve varies supply water temperature according to system demand.

Air temperature in the central operating gallery is a minimum 68 degrees Fahrenheit while 45-degree temperatures are maintained in filtering areas on each side of the gallery. One of the reasons for selecting this type of radiant heating installation was to minimize convection currents between the heated operating gallery and the unheated filter area, thereby minimizing wall and window condensation problems.

A total of 3,029 feet of ¾-inch diameter, wrought iron pipe was fabricated into coils of 12-inch centers in both installations, running from and returning through 2 inch diameter supply and return piping.

The insulated ceiling installation is enclosed in 4 inches of concrete while the floor radiant heating panels are embedded in 7½ inch thick concrete topped with ¾-inch thick quarry tile.

Water is heated to 160 degrees Fahrenheit through a heat exchanger utilizing superheated steam from the exhaust of steam turbine generators. Separate pumps move this hot water through each of the wrought iron pipe radiant heating zones at a rate of 20 gallons per minute to handle heating requirements of the 40,000 cubic-foot operating gallery.

Theoretical considerations are applied to the . . .

Basic Biology of Stabilization Ponds

by Wesley O. Pipes, Jr.
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■ THE ACADEMIC TRAINING of engineers is directed toward teaching design procedures based on analytical reasoning from first principles. This training is sound because all of the steps of the design process are exposed to relatively quick analysis, and incorrect procedures may be identified without recourse to extensive experimental investigations. In actual practice, many situations arise in which the method for developing a logical design procedure is obscured by lack of familiarity with the principles which are applicable.

The design of some waste treatment processes is based upon physical, chemical, and hydraulic principles. The design of biological waste treatment processes is based almost entirely upon past experience and rule-of-thumb procedures. Applicable biological principles do exist but they have been largely ignored because of a lack of communication between biologists and engineers.

In order to make quantitative evaluations of presently employed biological waste treatment processes and to improve upon design and operation, it would be beneficial to have a rational theory which gives an analytical description of the biological phenomena which occur. Since many biological phenomena are rather complex in the ramification of intra and interspecies relationships, the desired rational theory is not immediately forthcoming even when the applicable biological principles are enumerated concisely. Sanitary engineers should not let this deter them from attempts at rational models of biological waste treatment units.

The design and operation of stabilization ponds in the light of some biological principles is to be considered in this analysis. Many of the conclusions about the design and operation of stabilization ponds which may be derived from the logical application of biological principles are the same as empirical observations as to what is *good design practice* or *good operating practice*. Showing that these conclusions may be derived from first principles should make the designers and the operators feel more secure about their observations and increase the willingness to cut down on the factors of safety, thus resulting in better utilization of the purification potential of stabilization ponds. Some of the conclusions reached may be somewhat new and it is hoped that they will result in a re-evaluation of design and operating practice.

A biological waste treatment process is limited in efficiency by the capabilities of the biological population. Any population of organisms will have certain capacities to make transformations of the substrate upon which it is living. In waste treatment it is the type and degree of transformation in the substrate, the suspended and dissolved organic material, which is used as a measure of the overall effectiveness of the process. Thus one apparently attractive approach to the problem of controlling biological waste treatment processes is to determine what population is desired and to study methods of population control.

The inherent capabilities of a given biological population will cover a rather wide range of activities. The activities carried out by a population, and the rate at which the activities are carried out, are dependent to a large extent on the specific environment in which the population exists. It is necessary to consider environmental factors as they effect both the composition and the activities of the biological population.

The population of any environment is controlled by the physical, chemical, and biological factors in the environment. These factors combine to produce certain niches in any habitat. Because of inherent differences in species, one species will be best adapted to grow and carry out its metabolic activities in a given niche. It is the interaction of the environmental factors and the species present which determine the future population of the environment. This is an example of the principle of the survival of the fittest.

Physical Factors

The important physical factors affecting the population of a stabilization pond are temperature, light, and specific gravity. Hydrostatic pressure is also of importance in determining distribution and activity in certain aquatic environments. Since stabilization ponds are generally shallow, the variation in hydrostatic pressure and its effects on the organisms present are usually negligible.

For every microorganism which has been studied, there is a definite temperature range in which it is able to carry out its metabolic activities. If the variation of temperature of the environment exceeds the range of temperature tolerance of the organisms greatly, or if there is a sudden temperature change, death of the organisms may result. Therefore, for proper operation of a stabilization pond, extreme or sudden variations in the temperature of any part of the environment should be avoided.

Within the temperature tolerance range, the effect of temperature upon the metabolic activities is de-

*Presented at the Sanitary Engineering Symposium of the Chicago Metropolitan Chapter of the American Public Works Association, Evanston, Ill., April 6, 1960.

scribed by the van't Hoff-Arrhenius relationship. This relationship has found such general application to chemical and biological phenomena that it is sometimes considered a first principle, although it may be derived from thermodynamic considerations. As applied to biological phenomena, it indicates approximately a doubling of the rate of activity with each 10° C rise in temperature. If we are interested in obtaining the maximum rate of activity of microorganisms in a stabilization pond, the pond should be designed and operated so as to maintain as high a temperature as possible without exceeding the temperature tolerance of the desired population.

The most important effect of light on a stabilization pond is its effect upon photosynthesis. If photosynthesis is desired as a method of oxygen supply, light must be provided at the proper intensity to achieve the desired amount of photosynthesis. The algae which occur in stabilization ponds have a range of light intensity tolerance in which the photosynthetic rate is independent of light intensity. This range is approximately 500 to 5000 foot candles[1]. On the low side of this range, photosynthetic rate decreases with decreasing intensity to zero. On the high side of the range, photosynthetic activities are inhibited by high light intensity. Although it would be difficult to increase the intensity of sunlight at the surface of a pond and uneconomical to light the pond artificially, it is feasible to control the intensity of light incident on a given algal cell by controlling turbidity and floating solids.

The specific gravity of the organisms present in a stabilization pond will determine whether the organisms have a tendency to float, remain suspended, or settle. It is rather difficult to control the specific gravity of microorganisms precisely enough to effect their distribution in a stabilization pond. However, if it were decided that floating organisms were undesirable, it would be simple enough to design an effluent collector which would remove a proportionately greater fraction of the floating organisms than of those with greater specific gravities and vice versa. The design and operation of the effluent collector offers one method of population control.

Chemical Factors

The important chemical factors in the stabilization pond environment are the nutrition factors, the pH effects, and the toxic effects. The control of any of these chemical factors in the environment offers a rather precise tool for use in the population control. Unfortunately, little study has been made of the control of these chemical factors within the economic capabilities of the waste treatment operation.

The nutritional effects of a specific organic compound depends to a large extent on the concentration of the compound and on the characteristics of the organism in question. Many substances are known which stimulate growth in low concentration, but which are toxic at higher concentrations. Many substances, such as phenol, which are toxic for some organisms are growth substrates for others. One of the principles of microbiology is that for every naturally occurring organic compound there is some microorganism which is able to metabolize it.

The nutritional requirements of organisms may be classified as follows: 1) an energy source; 2) the macronutrients, C, H, O, N, P, K, and S; 3) micronutrients such as Fe, Mg, Ca, B, Zn, Cu, Mn, Co, Mo, etc., and 4) certain specific organic structures which are known as growth factors. As long as the nutritional requirements of a microorganism are fulfilled, the organism will grow and metabolize at a rate dependent upon the physical environment. When a nutritional requirement becomes limiting, the growth and metabolic rate will be a function of the availability of the limiting nutrient.

All organisms derive their energy from the oxidation of organic compounds which they encounter in the environment or which they produce by photosynthesis. The oxidizing agents which may be employed are oxygen, nitrates and nitrites, sulfates, carbonates, and organic compounds. As in any oxidation-reduction reaction, the oxidizing agents employed by microorganisms are reduced. During the aerobic oxidation of organic matter, oxygen is reduced to water and carbon dioxide. The reduced forms of the nitrogen compounds and carbonates are ammonia and methane respectively, which are not particularly objectionable, but not as innocuous as water and carbon dioxide. The reduced forms of sulfates and organic compounds are odorous and quite objectionable and, in addition, are often toxic to aerobic organisms.

All other factors being equal, an aerobic organism will have a higher rate of metabolic activity than an anaerobic organism. This, added to the fact that the metabolic products of aerobic organisms are generally more stable and less objectionable than those of anaerobic organisms, indicates that stabilization ponds should be designed and operated to contain a finite concentration of dissolved oxygen as much of the time as possible. It is also important to limit the anaerobic periods of the pond, if they are necessary at all, to a few hours at a time in order to prevent the build-up of the metabolic products of anaerobes to concentrations in which they are toxic to the aerobes.

In most municipal and industrial wastes the macronutrients H, O, K, and S are normally present in excess. The nutrients which may become limiting in a biological waste treatment unit are C, N, or P. The limiting nutrient will of necessity be at a low concentration in the treatment unit and, thus, at a low concentration in the effluent. Since the reduction in the carbonaceous BOD is the main concern in the treatment of organic wastes, stabilization ponds should be operated in a manner that would make organic carbon the limiting nutritional factor.

Organisms vary greatly in their requirements for micronutrients and growth factors. Normally, these nutritional requirements are not of interest in waste treatment processes because if the activities of one species of organism is limited by a micronutrient or a growth factor, it will be quickly replaced by an organism with similar metabolic capabilities but without a requirement for the limiting substance.

The pH range of a fresh water environment will have a profound effect on the composition of the microbial population present. All organisms have a pH tolerance range in which the actual pH value has little effect on the metabolic activities of the organisms present. However, wide or sudden variation in the pH of a stabilization pond will have an

adverse effect on the organisms. A stabilization pond should be designed and operated so that the pH range will be optimum for the desired organisms and sudden variations in pH are not possible.

The toxic effects of some specific wastes on biological waste treatment units has been studied in detail. Here the condition to be avoided is a sudden increase in the concentration of a substance which might be toxic. Perhaps in the future it may be possible to use the selective toxicity of specific wastes as a means of controlling microbial populations in a waste treatment unit, but up to now the basic information necessary for this has not been elucidated.

Biological Factors

The important biological factors in an environment are the interrelationships of species. One of the principles of ecology is that any species present in a habitat will have some influence on all other species present. These relationships are difficult to classify and tabulate because they form a continuous spectrum all the way from antagonism and competition to complete mutual dependence. For the stabilization pond, the best that can be done with presently available information is to group the microorganisms into broad categories and indicate the function of the organisms belonging to each category.

In a stabilization pond primary heterotrophs feed directly on the organic material introduced with the waste. These are the most important organisms from the waste treatment aspect because they serve to oxidize or metabolize most of the organic waste material. Most of these organisms are bacteria but a few protozoa and fungi could qualify for membership in the group.

In addition to the primary heterotrophs, there will be present secondary and tertiary heterotrophs. These organisms feed on the cells of the primary heterotrophs or on their organic waste products. They serve a useful function in carrying the organic carbon processed by the primary heterotrophs through another biological cycle with the concomitant loss of a portion of the energy and carbon in the form of carbon dioxide. The secondary and tertiary heterotrophs should not be allowed to be so active as to decrease the concentration of primary heterotrophs in the treatment unit below the optimum level.

The autotrophic organisms, mostly algae, in a stabilization pond produce oxygen by the photosynthetic process. This oxygen is employed by heterotrophs for the stabilization of the organic wastes. The autotrophs also fix carbon dioxide produced by the heterotrophs or absorbed from the atmosphere and produce organic material in the form of new cells or excreted organic wastes. This organic material may exert an additional load on the oxidative capacity of the pond. In extreme cases it is possible the effluent from a stabilization pond may contain a greater concentration of organic carbon than the influent and thus a greater potential BOD. This situation becomes quite critical when the effluent from the pond is introduced into an environment which is not favorable to the autotrophic organisms, in which they may die and the potential BOD which they represent may be exerted.

The problem of the control of the biological factors in a stabilization pond environment is one of keeping a balance between the various groups of the population. The primary heterotrophs should be encouraged as much as possible while the secondary and tertiary heterotrophs and the autotrophs should be controlled so the benefits of their metabolic activities may be gained. Their population does not reach such a high concentration, however, that they produce adverse effects.

Kinetics of Growth and Metabolism

One biological principle not considered yet is that all biological activities are autocatalytic. The overall rate of any biological activity is dependent upon the concentration of one of the products of the activity, the organisms themselves. Actually, the biological activity will not commence until the organisms are present in at least a small concentration. When the organisms are present, the rate of biological activity will be directly proportional to the concentration of organisms until some factor becomes limiting. When a factor becomes limiting, the rate will be a function of the limiting factor and the concentration of organisms.

Reaction vessels for a continuous flow process may be classified as to the degree of mixing somewhere between the two extremes of the *piston flow* vessel with no mixing and the completely mixed vessel in which the concentrations of the reactants and the products are the same throughout the entire vessel. For reactions in which an increase in the concentration of the products decreases the net reaction rate, the piston flow culture is ideal. For autocatylic reactions, the completely mixed vessel will be the ideal.

A stabilization pond may be considered to be a reaction chamber in a continuous flow process. Since the activities of the organisms present are autocatalytic, the ideal situation will be when the pond is completely mixed. In practice, since mixing costs money, an optimum degree of mixing must be decided upon, taking into consideration economic factors.

Conclusions From the Theoretical Considerations

At this point it is instructive to tabulate the conclusions which have been drawn from the foregoing discussion. These are:

1. Extreme or sudden variations in the temperature at any part of the pond should be avoided.

2. In order to obtain a high rate of oxidation of organic matter, as high a temperature as possible should be maintained in the pond without exceeding the tolerance limits of the desired population.

3. The growth and activities of photosynthetic organisms might be controlled by control of the turbidity and floating solids in a stabilization pond.

4. One feasible method of population control is to design the effluent structure to selectively remove greater proportions of those organisms with specific gravities either greater or less than unity.

5. In order to obtain maximum treatment efficiency, organic carbon should be the limiting nutritional factor in the pond.

6. Aerobic conditions should be maintained for as great a fraction of the time as possible and anaerobic conditions should be limited to a few hours at a time.

7. The pH of the pond should be maintained within the tolerance range of the desired population.

8. Sudden or extreme variations

in the pH of the pond should be avoided.

9. A stabilization pond should be operated so as to keep the population of microorganisms in balance. The primary heterotrophs should be the predominant group of organisms. The secondary and tertiary heterotrophs should not be allowed to reach such a concentration that they materially decrease the population of primary heterotrophs. The autotrophs should be limited to the minimum concentration at which adequate oxygen is produced.

10. As much mixing as is economically feasible should be employed.

Application of Biological Principles to Design and Operation

Having reached the above conclusions, it is now possible to consider what should be *good design practice* and *good operating practice*. In order to do this, it will be necessary to consider several specific problems and attempt to resolve these problems on the basis of the theoretical discussion.

One of the conclusions reached was that a stabilization pond should be operated to maintain aerobic conditions for as great a fraction of the time as possible. In order to determine what percentage of the time the pond will be aerobic or anaerobic, it is necessary to consider the balance of oxygen supply versus oxygen consumption.

There are two possible sources of oxygen for a stabilization pond, surface reaeration and photosynthetic oxygenation. Since it has been concluded that the population of algae in the pond should be kept as low as possible consistent with adequate oxygen supply, full use should be made of atmospheric reaeration and photosynthetic oxygenation as needed to maintain oxygen at an adequate concentration.

The rate of absorption of oxygen by a body of water in contact with the atmosphere has been formulated as

$$\frac{dD}{dt} = -rD$$

where D is the oxygen deficit, the difference between the saturation concentration of dissolved oxygen and the actual DO concentration, and r is the reaeration rate constant[2]. The factors, D and r, are dependent upon the past history and the physical and chemical characteristics of the body of water in question.

In order to maximize the rate of atmospheric reaeration, the oxygen deficit should be maintained as great as possible without attaining actual anaerobic conditions. Most microscopic aerobic organisms are able to grow optimally if the dissolved oxygen concentration is 1 mg/l or greater. This value may be taken as the desired dissolved oxygen concentration in a stabilization pond. The solubility of oxygen in fresh water decreases rapidly with an increase in temperature from 14.62 mg/l at 0° C to 7.63 mg/l at 30° C. If the dissolved oxygen concentration is assumed to be constant, the oxygen deficit will decrease with increasing temperature in the same manner as the DO saturation value.

The reaeration rate constant, r, is a function of many physical characteristics of a body of water. It is increased by mixing and by wind action on the surface of the water. Since it is expressed on a volumetric basis, it increases with a decrease in depth as the surface area to volume ratio increases. It increases with increasing temperature according to the exponential relation, $r = r_o e^{\alpha(t-t_o)}$.

For a stabilization pond it is impossible to predict the value of the oxygen deficit or the reaeration rate constant. However, it is possible to obtain an estimate of the rate at which oxygen may be absorbed from the atmosphere by assuming reasonable values for these factors. The reaeration rate constant has been found to vary between 0.1 and 1.0 for various bodies of fresh water. Figure 1 shows a plot of the magnitude of the reaeration rate as a function of temperature for various values of r. For these calculations the DO concentration was assumed to be 1 mg/l.

From Figure 1 it may be seen that the rate of atmospheric reaeration in a stabilization pond will be somewhere within the range from 0 to 10 mg/l/day. Actually the lower portion of this range, 1-4 mg/l/day, is probably more descriptive of the rates attained in actual practice. The higher values of atmospheric reaeration would only be attained in very shallow ponds less than 1 foot in depth which were exposed to considerable wind action.

The above range of values for the rate of atmospheric reaeration would indicate a detention period of between 10 and 100 days would be needed to satisfy a biochemical oxygen demand of 100 mg/l. If a waste had a 5 day BOD of 100 mg/l and the temperature of the pond were 20°C, the rate of oxygen consumption would be considerably greater than the rate of oxygen absorption and the pond would be anaerobic most of the time. Probably the only condition under which an aerobic stabilization pond could depend solely upon atmospheric reaeration would be when the temperature of the pond is low enough that BOD is exerted quite slowly.

The rate of oxygen production in a stabilization pond due to photosynthetic oxygenation is dependent upon the amount of algae produced in the waste and the ratio of the weight of oxygen produced to the weight of algae produced[3]. For a waste with a BOD of 100 mg/l it has been shown approximately 150 mg/l dry weight of algae may be produced in a period of about 3 days. There have been 300 mg/l of algae produced in a waste with a BOD of 300 mg/l. The ratio of the weight of oxygen produced to the weight of algae has been found to vary between 1.25 and 1.75. The rate of oxygen production by algae in a stabilization pond may be as great as 175 mg/l/day. The rate of oxygen supply from photosynthesis in a stabilization pond may be assumed to be within the range from 0 to 200 mg/l/day.

Although the values given above lack much in the way of precision, they should at least be reasonably reliable estimates of the order of magnitude. It may be seen that the rate of oxygen supply from photosynthesis is potentially about ten to twenty times as great as the rate of oxygen supply from atmospheric reaeration. If the full purifying capacity of a stabilization pond is to be realized, photosynthetic oxygenation must play a large part in oxygen supply.

It has been concluded previously, the limiting nutrient in a stabilization pond should be carbon. Studies of actual stabilization ponds have concluded that this is usually the case due to the composition of the dissolved and suspended material in domestic sewage[4]. The only other nutrients likely to become limiting are nitrogen and phosphorus.

Nitrogen may become limiting if appreciable amounts of organic car-

bon other than that of the sewage are introduced into the pond. The mechanism by which the organic carbon in the pond may be increased is photosynthetic fixation of carbon dioxide absorbed from the atmosphere. A high pH value in the pond will favor more rapid absorption of CO_2 from the air. The algae present in a stabilization pond may secrete relatively large amounts of soluble, oxidizable organic matter if they are growing slowly as they would in ponds with long detention periods.

The concentration of the phosphate ion may become the limiting factor in a stabilization pond if the pH value of the pond is allowed to exceed values of about 9.0. At reactions more basic than 9.0 mono and di-basic acid phosphate ions are converted to the orthophosphate ion. Since calcium orthophosphate is very insoluble, it may precipitate removing most of the available phosphorus from the pond[4].

In order to assure that organic carbon is the limiting nutrient in a stabilization pond, it is necessary to prevent either nitrogen or phosphorus from becoming limiting. In order to assure this is the case, the detention period should be held to less than ten days and the pH of the pond should be maintained at values less than 9.0.

If a stabilization pond is operated without photosynthetic oxygenation, it will probably become anaerobic very quickly at temperatures above 10° C. If algae are to supply half or more of the oxygen, then higher temperatures and more rapid oxidation rates may be employed. The thermal tolerance range of the heterotrophs in a pond will extend to the 40-45° C range. The thermal inactivation temperature of mesophyllic fresh water algae is about 35° C. This would be an absolute maximum unless the pond were to be heated artificially and thermophyllic algae employed. The practical maximum temperature of a stabilization pond is probably somewhat less than 30° C.

The principal sources of heat for a stabilization pond will be solar energy and the heat contained in the influent sewage. Neither of these sources may be increased effectively; however, certain steps may be taken to assure maximum absorption of solar energy. The water surface of the pond should be kept clean and the pond bottom should be dark to maximize penetration and absorption of solar energy. If the waste is pretreated, it should certainly be skimmed to remove grease and floating solids. The effluent collector should be designed and located so any wind action on the surface of the pond will provide effective removal of surface films.

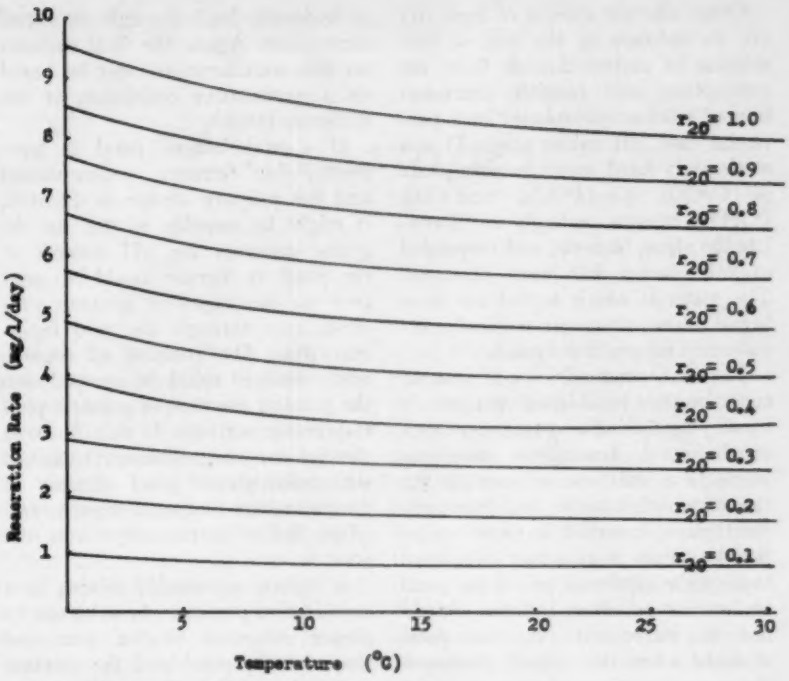

Figure 1. RATES of Atmospheric Reaeration.

The principal heat losses from a pond will be loss by evaporation of water from the pond surface and the heat content of the effluent from the pond. The evaporative heat loss may be decreased by protecting the surface of the pond from wind as much as possible. Decreasing air movement on the surface of the pond by wind breaks etc. would decrease surface reaeration and mixing. The effect of air movement on evaporation, mixing, and reaeration will have to be evaluated quantitatively before the optimum design criteria may be selected.

Selecting the proper depth for a stabilization pond is also a matter of balancing several factors quantitatively. In the summer when the primary oxygen supply is from photosynthesis, it is important that oxygen be produced in all parts of the pond. The light intensity at the bottom of the pond should be greater than the intensity at which respiratory oxygen consumption by the algae is equal to photosynthetic oxygen production (about 24 foot candles) so excess oxygen is available for oxidation of organic matter. During the winter this consideration is less important. The depth of the pond may be increased to provide better retention of heat.

It is quite important that the pH of a stabilization pond be controlled as precisely as possible. Unfortunately, this is one factor which has received very little attention in design and operation to date, although it is probably the critical factor in limiting the efficiency of stabilization ponds.

During periods of high light intensity the algae use up CO_2 at a much higher rate than it is being produced and the pH of a stabilization pond may reach values as high as 11.0. Most of the heterotrophic organisms present have a pH tolerance range between 6.0 and 9.0 and the optimum range will be between 7.0 and 8.0. Although algae have wider pH tolerance ranges than bacteria, no doubt these high pH values inhibit photosynthetic oxygen production to some extent. The oxidative capacity of the pond is effectively reduced to almost nil just when the maximum rate of oxygen supply is attained.

Other adverse effects of high pH are an increase in the rate of dissolution of carbon dioxide from the atmosphere and possible precipitation of calcium phosphate. In a particular case, pH values above 11 and moderately hard water, a precipitate of $CaCO_3$, $Ca_3(PO_4)_2$, and $Mg(OH)_2$ copious enough to flocculate the algae, bacteria, and suspended organic matter has been observed. The material which settled out soon began to decompose anaerobically, resulting in failure of the pond.

The only method of pH control economically feasible at present is by varying the influent rate and depth of the pond. Instead of supplying waste to a stabilization pond at the rate at which it comes into the treatment plant, it would be better practice to supply it at a rate calculated to keep the afternoon pH of the pond as low as possible. Influent should not be introduced into the pond at night when the rate of photosynthetic oxygenation is zero to avoid anaerobic condition. The influent rate should be low in the morning and increase as the light intensity increases. The depth of the pond should be allowed to increase during the day and the effluent removed from the pond at night. A daily variation in the pond depth of as much as two feet may be needed.

Obtaining the desired diurinal variation in the influent rate will, of course, necessitate some type of holding tank, covered to keep down odors, and would result in a waste of hydraulic head through the treatment plant. Again, the final decision on this consideration must be based on a quantitative evaluation of the economic factors.

If a stabilization pond is proceeded by primary sedimentation and the primary sludge is digested, it might be possible to use the digestor contents for pH control in the pond. A digester could be operated so the digestion process proceeds only through the acid digestion step. The solution of organic acids obtained could be pumped into the pond at the time of greatest photosynthetic activity. If this is done, the digester contents should be mixed with recirculated pond effluent so the immediate oxygen demand is satisfied before introduction into the pond.

A certain amount of mixing in a stabilization pond can be achieved by proper selection of the size and shape of the pond and the location and design of the influent distributor. The pond should be as nearly square or round as possible and the influent should be introduced in the center. The influent distributor should be designed to produce horizontal flow velocities as great as possible radiating in all directions from the center of the pond. The distributor should be designed so the influent could be introduced at the surface of the pond if the influent is colder than the pond contents, or on the bottom of the pond if it is warmer than the pond contents. Several effluent collectors should be located judiciously around the perimeter of the pond. The possibility of recirculation of pond effluent should be considered in the design.

Summary and Conclusion

A theoretical discussion of the biological factors contributing to the purification of an organic waste in a stabilization pond has been presented. Several factors to be considered in the design and operation of a stabilization pond have been discussed in the light of the conclusions reached from the theoretical discussion. It may be concluded that by the application of biological principles, it should be possible to improve the efficiency of use of the land area which is devoted to waste treatment in stabilization ponds.

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MSD Names Gain and Gallup to New Posts

Edward J. A. Gain, chief of the Engineering-Design Department of the Metropolitan Sewer District, has been promoted to the newly created office of Technical Assistant to the Executive Director. Mr. Gain, who has held his present position since September 1, 1954, in the formative days of MSD, assumed his new duties February 1.

The new position will be one of the most important engineering positions within the District. Among the major problems facing Mr. Gain is the pollution abatement program of the Mississippi River and its relationship to the Flood Control activities of the U.S. Army Corps of Engineers. In the latter program, the Army Engineers will construct 21 storm water pumping stations which, upon completion, will be turned over to MSD for operation and maintenance.

A graduate of Washington University in the class of 1925, Mr. Gain is a Registered Engineer in the State of Missouri. In his service with the City, he was Engineer in charge of Sewer Design for ten years, and in his final year was Assistant to the Chief Engineer of the Sewers and Paving Section. In the summer of 1954 when MSD was being activated, he was asked to organize the Engineering-Design Department and, to accept the appointment, was granted a year's leave of absence by the Board of Public Service. At the end of the year he decided to remain permanently with the Sewer District.

Michael Meyer Gallup, an engineer of 38 years' experience with sewers and other construction, has been appointed Chief of Engineering, succeeding Mr. Gain.

He joins MSD after 16 years as an officer of Tarlton Contracting Company, Inc., a position he resigned in January. While with Tarlton he was in charge of heavy construction activities of the firm. Following university graduation in 1921, he entered the construction field and in the years following was employed in sewers, tunnels, and allied types of construction in many parts of the nation.

Mr. Gallup has been active for years in the Associated General Contractors and only last fall was elected vice president and chairman of the Heavy Construction and Engineering Division of the organization.

Partially Oriented on . . . . . .

Landscrapes

Now that landscape artists have entered the field of water engineering (take cover boys!), just anything may happen. I shall be disappointed if it doesn't. The thing about artists is that they are men of BOLD CONCEPTION. They excite our imaginations, stimulate our optic nerves and make us have reactions and things. (Oh, come on. Do wake up for a minute.) This is all to the good; we all need stimulating and jerking about—just look at you now, lolling around like a left-over from last year's beach parties. The trouble with us engineers is that we have no IMAGINATION. All we have is imagination—black spots in front of the eyes which turn into blue flashes at night when we are trying to get to sleep. That's not Imagination—just a bad conscience or too much cheese for supper. No. Real IMAGINATION is thinking up bold things to say, like our landscape artist has said about dams—"The trouble with dams is that they generally cut straight across a valley and hit the banks on either side with a bang. THIS WON'T DO!"

I must confess that my unstimulated brain has never had a thought like that before. Why, every dam I've built did just that. BANG, we went, straight slap into the hillsides at the ends, and I thought it was right! What we *ought* to have done, I can see now, was to "shape it gradually into the hillside contours in a smoothing out process." I do agree. The noise when we hit the hillside was terrific; I would gladly have welcomed a quiet smooth glide into the contours so that I didn't wake up in my office every time it happened. With all these dams being built all over, it would confer a benefit on everyone to stop this nonsensical crashing and banging into hillsides when everyone is crying out for a bit more peace and quiet. As from now, we should stop it.

Curves too, our landscape artist suggests, are a *must* for a dam—two curves, three curves, any number of curves. For this year's *haute couturie* for dams let us have plenty of curves. All must be soft, flowing sweetness to the eye as we mould our constructions to fit in with the landscape. "There are no straight lines in nature," says the landscape artist, "and a curve is an essential part of the appearance of a dam." Good, methinks? Yes—but a word of warning,—beware of bulges! We may curve, but not bulge; to bulge is disastrous. Take this tentative design for a little thing of a dam I am about to run up (figuratively); do I bulge here perhaps? Shall I take in a little at the sides, or should I drop my crestline just a fraction? Perhaps we are a teeny bit slim with our foundations, and if I were to pad out here just a little, don't you think that might be better? Aaah—just right! See—she curves in, then she curves out; now here she is changing grade just a fraction before entering this suspicion of a cycloid I have added, and here we are . . . . bother! How did that happen? We've got in the wrong valley . . . . never mind, let's try it out again.

Now let us consider the water; how about that? That's flat isn't it; oughtn't we to do something about that? You can't have a piece of flat water in an undulating piece of countryside. Perhaps we had better call in the landscape artist again; he never mentioned the water. How about a series of inverted cycloidic islands jumping about from side to side to break up the monotony? Perhaps we could have about a dozen, and then we could stick the draw-off tower over here.

I *beg* your pardon, did I say "stick"? What I meant was, where aesthetically shall we place the draw-off tower and what functionally satisfying shape shall we give it—circular you say? I see—"because it is functionally satisfying, ideal aesthetically, gives a perfectly symmetrical reflection in the water, and is completely satisfactory when seen from all points of view." Fancy a circle doing all that but are we sure this water will reflect? Oh, never mind, we'll take a chance on one or two days in the year without wind. Let us have circular penstocks too, circular pipes, circular headstock wheels, circular windows, and—I know what—a circular bridge to connect to the mainland. See; you can come on one side and go on the other; or you can keep going and come around again. What a fine place for a constitutional. (Sorry, no dogs permitted). That's enough. No stop it, you are making me giddy; you don't want to overdo these things.

The more I try this landscaping of reservoirs the more fascinating I find it. For years we have been building straight level dams slap into hillsides, with draw-off towers popping up just anywhere convenient. Mind you, there is an excuse. You can't look anywhere these days without seeing straight level roads, straight level flat bridges, straight level-by-level flats of flats, and straight level and cubical blocks of offices. I don't see that water engineers have been the worst inflicters of straight-line architecture. After all, just think of the PYRAMIDS . . . . Yes the PYRAMIDS, I wonder what went wrong with them? Shouldn't they have been smoothed into the natural landscape? Let's smooth everything away and just get back into caves. (Mind where you put those bones! Don't be a litter bone-leaver.)

On the other hand—let's not! Let us try instead to build dams as noble as PYRAMIDS. Let us have crestlines straight and level as the water; and

CONTINUED ON PAGE 162

Epoxy-Vinyl Paint System

by
DR. WILLIAM WETTACH
Industrial Paint Co.
Sewickley, Pennsylvania.

■ MOST CONSULTING ENGINEERS and water department officials agree that vinyl coatings have been the only type materials which would adequately protect the interior steel surfaces of water tanks from long exposure to water immersion and water vapor. This is based on the consideration that after years of service, inspection of the interior surfaces of many tanks has shown that those coated with vinyls have been well protected, while those coated with other specification or proprietary brand paints have failed. In spite of this excellent record, engineers and authorities are reluctant to specify a vinyl product for coating the interior surfaces of water tanks. Their objection is the high cost application. To overcome this objection and still give the same protection to the steel on the interior of the water tank, an epoxy-vinyl coating system [1] has been developed.

Conventional Primer

One of the products used in the conventional vinyl system is the two component wash primer, Specification MIL-C-15328A. This requires mixing just prior to use and has a usable *pot life* of only eight hours. There is always the danger of applying too heavy a coating of this primer which results in poor adhesion of the succeeding coats. It is also imperative to coat the wash primer within 72 hours. These hazards of application, combined with the fact the wash primer will only have a coating thickness of .3 to .5 mils make it an undesirable product for use in either the shop or field. The usual practice is to apply three succeeding coats of vinyl materials over this wash primer to obtain a total thickness of 3.5 to 4.0 mil.

Improved Primer

An epoxy red oxide chromate primer [2] has been developed to replace the wash primer and the first coat of vinyl red lead, Specification MIL-P-15929A. The epoxy primer eliminates one application and still gives a dry film thickness greater than the other two coats combined.

Intermediate Coat

The conventional vinyl system uses a vinyl red lead, Specification MIL-P-15929A, tinted with lampblack to a brown color for the intermediate coat. Instead of this type intermediate coat, a heavy duty, high-solids gray vinyl coating [3] has been developed to give the proper bond to the epoxy primer, and to obtain the required dry film thickness.

Finish Coat

For the finish coat both systems require a vinyl aluminum. In place of the low solids aluminum paint, Specification SSPC-paint 8-55T, used in the conventional system, the epoxy-vinyl system uses an unusually high-solids vinyl aluminum [4] which can be applied more rapidly and requires less paint per square foot at a dry film thickness of 1 mil.

Formulations Tested

The modified epoxy-vinyl system eliminates previous objections to the all-vinyl system and still gives the protection with which most engineers are familiar. This system has been tested both in the laboratory, in small tanks, and in municipal tanks in service. The laboratory tests consisted of immersing welded steel panels which had been grit blasted, primed and finish coated in tap water for periods of two years. Periodic inspections showed complete lack of blistering and other undesirable characteristics common to many conventional coating systems exposed to water immersion. Small welded test tanks prepared and coated with the epoxy-vinyl system performed equally well. The results of tests on municipal tanks in service are described in a later part of this article.

Fixed Applications

This article describes in detail, repainting the interior of an old tank, and painting the interior of a new one. These two types of tanks were chosen to show that the epoxy-vinyl system is applicable to either category, and that approximately the same coverage figured on a 1 mil basis was obtained for the products of this system by two different painting contractors.

Settling Tank Painted

The repainted tank is a 750,000 gallon settling tank operated by the North Fayette County Municipal Authority at Connellsville, Pa. The interior of this tank had not been painted for many years, and the surface had rusted considerably, with pitting to depths of 1/16 to 1/8 inches. A great deal of sandblasting was required to prepare the metal adequately for painting. One hundred tons of #20 Dry Silica Sand was applied by a 5/16 in. high velocity sandblast nozzle at 100 psi to remove the remaining paint and rust on the 28,000 square feet of interior surface.

TANK AT Wooster, Ohio painted blue using the Epoxy-Vinyl Paint System.

After the surface received this commercial blast, the coatings were applied. All paints were used as manufactured, no thinner being added at the job. The first coat was epoxy primer and was applied by a Graco Airless Spray using a Tungston Carbide 400017 nozzle at 1800 lbs pressure. This primer dried to a dry film 1.7 to 2.3 mils thick and had a cover-

age of approximately 370 square feet/gallon/mil.

The second coat was the gray vinyl intermediate coat. The method of application was the same as used for the epoxy primer. The dry film thickness of this second coat was 1.5 to 2.0 mil, with a coverage of approximately 250 square feet/gallon/mil.

Finally, the finish vinyl aluminum was sprayed in the same manner to a dry film thickness of 1 to 1.2 mil, with a coverage of approximately 200 square feet/gallon/mil. The total dry film thickness of the three coats, as measured by an Elcometer, was between 5 and 6 mil. The tank is presently in service. The first inspection of the interior of the tank was made after a period of 14 months. At that time, everything was found to be in excellent condition.

All of the information for the painting of the Sedimentation Basin was supplied by Mr. J. T. Johnson of the Bease-Johnson Company of Pittsburgh, Pa., the painting contractors. The coating system was specified by the William J. Murdock Company, Consulting Engineers of Pittsburgh. They also supervised the work and checked the coating thicknesses.

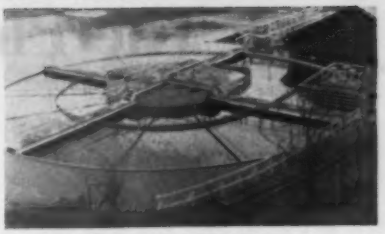
Storage Tank Painted

The new tank which was coated is a standpipe type with a "sphericone" roof and has a capacity of one million gallons. The owner is the Water Department of the City of Wooster, Ohio. This tank was fabricated by the Chicago Bridge & Iron Company at Greenville, Pa. Their method of surface preparation is by pickling. After this surface preparation, the epoxy primer was sprayed by conventional spray equipment to a dry film thickness of 1.5 to 1.75 mil, with a coverage of approximately 400 square feet/gallon/mil. The slightly higher coverage in this instance is probably due to the smooth surface as contrasted to the blasted. Curved sections of new tanks are not shop painted three to four inches from the edges. This is done so that these sections may be welded together more easily at the erection site. However, in arriving at the coverage of this primer, this unpainted area was taken into consideration.

After erection of this tank at Wooster, Ohio, it was necessary to sandblast the welds to remove flux and splatter, Pennsylvania Glass Sand size 4Q-Rok was used in a Clemco Pulsair gun using a ¼ in. I.D. Venturi nozzle. The next step was to apply the epoxy primer over the blasted area. The application of the paint was done with a Graco Airless spray equipped with a Tungsten Carbide 400017 nozzle at 1800 lbs pressure.

The intermediate coat vinyl was then applied over the whole interior surface with the same type of gun. The vinyl coating had a dry thickness of 2 to 2.5 mil, and a coverage of 260 square feet/gallon/mil.

The interior surface was sprayed in the same manner with a finish coat of high solids vinyl aluminum paint. It dried to a film thickness of 1 to 1.2 mil, with a coverage of approximately 210 square feet/gallon/mil. The total dry film thickness of the entire painting system on the interior surface was from 5 to 6 mil. This tank has been in service now for several months.



SEDIMENTATION BASIN at Connellsville, Pennsylvania.

All of the information for the painting of the tank at Wooster, Ohio, was supplied by the Virginia Erection Corporation of Pittsburgh, Pa. The coating system was specified by Jones, Henry & Williams, Consulting Engineers, located at Toledo, Ohio.

References

1. Nocoro Epoxy Vinyl Paint System.
2. Nocoro Epoxy Red Oxide Zinc Chromate Primer M-4800.
3. Nocoro Gray Vinyl Intermediate Coat M-4820.
4. Nocoro Aluminum Vinyl Finish Coat M-4902.
5. Same as Number 2.
6. Same as Number 3.
7. The exterior of the tank is coated using the same system with the exception that Nocoro Vinyl Aluminized Blue-Green M-4947 was used as a finish coat in place of Aluminum.

Butrico Receives PHS Appointment

Frank A. Butrico, Sanitary Engineer, Director Grade, has been appointed to the position of Assistant Chief Engineer for the Public Health Service in the immediate office of the Surgeon General and working directly with the Chief Engineer, Mark D. Hollis.

The creation of this new position follows the recommendations of the Study Group on the Public Health Service Mission which urged a strengthening of the Service's top administrative structure, together with greater emphasis on leadership and coordination of the Service's increased activities in both environmental health and in comprehensive health services in states and local communities.

Mr. Butrico is a career officer in the Public Health Service Commissioned Corps, having begun this service in 1944 in Washington, D. C., with the Interstate Carrier operation. Successive assignments included Assistant Chief of the Interstate Carrier Program, Assistant Regional Engineer for the New York Regional Office of the Service, and Chief, Engineering Resources Program, in the Washington Headquarters since 1955. These positions involved leadership in the broad range of sanitary engineering activities.

In 1960 Mr. Butrico was assigned by the Surgeon General as Executive Director of the staff which planned and organized the recently held first National Conference on Water Pollution, called by direction of the President.

He has represented the Service and engineering societies at both national and international gatherings; he is the author of numerous papers in professional journals and other publications on a variety of sanitary engineering problems; and is either a member or active nationally as an officer or committee chairman in such groups as the National Society of Professional Engineers, the ASCE, the American Public Health Association, the WPCF, the AWWA and related societies. He is also a Diplomat of the American Academy of Sanitary Engineers and a member of the Board of Trustees of the American Sanitary Engineering Intersociety Board.

fusing The Phenol Frenzy*

by JOHN E. KINNEY
Sanitary Engineering Consultant,
Ann Arbor, Michigan

■ FANTASTIC IS THE WORD to describe the role of phenol in pollution control. Few water constituents receive so much attention. Arguments, discourses, schools, studies, surveys, laws and regulations are concerned with it.

Why? In that single-syllable question lies the essence of the problem. A wrong answer has directed the activities of scores of people. A correction can offer direction toward accomplishment.

Actually, the wrong response resulted from an incompleted line of reasoning. It was not the result of reasoning but merely an expression of something everybody thought they knew: *phenol causes taste and odor in water supplies.*

The fully completed line of reasoning would have shown that the objective of the pollution control program was the protection of public water supplies from taste and odor. The logical sequel would have been to ask what the role of phenol is in taste and odor control.

It must be recognized, once the short-range and limited thinking was accomplished, there was a tremendous expenditure of energy in gathering detail, data and misinformation on phenol. The results permitted conflicting reports and ranges in concentrations needed to put phenol under control.

What Is Phenol?

With nearly forty years of newspaper publicity on phenol, it is easy to assume everyone knows what phenol is. One more illustration of how erroneous assumptions can be. The lack of knowledge of what phenol is has not been confined to the man on the street. How others, purportedly familiar with the subject, have been developing new concepts will be shown later in this article.

In simple terms, phenol is an organic chemical. It can be obtained from coal. It is used as a germicide. It can be obtained at a drug store under the name of carbolic acid. Its characteristics are such that analytical procedures commonly used for phenol in pollution control may be used to measure other similar types of compounds.

Control of Phenol

Obviously, if phenol has no role in taste and odor control, there would have been no basis for starting a fuss and furor on phenol. What its role was supposed to be was pointed up by a series of incidents. Occurence of chemical tastes at water plants located on rivers downstream from coke plants indicated the coke plants to be sources of trouble. Coke plants distill coal and recover coal tar products. An index of recovery is the chemical compound phenol. Phenol could be measured. Phenol concentration was the gauge used on the discharge.

A HISTORY OF PHENOL and the attempts to Control its Effects

This knowledge, gained forty years ago, was supplemented by data developed by the U. S. Public Health Service. The PHS learned that, and this quote comes from a paper published in the early twenties: "if the chlorine dosage is properly controlled", chlorination of phenol will develop chloro-phenols that give objectionable tastes and odors. What the conditions were for application of chlorine was not appreciated. Nor was full consideration given to the method of test. Only the result received any attention.

State regulatory agencies placed limits on phenol. It was banned in Pennsylvania. Other states expressed the limit in terms of a concentration in the stream. Then there was a limit, as in West Virginia, on the concentration that could be added to the stream concentration. The International Boundary Commission devised a combination: limiting the concentration in the stream and limiting the concentration in the effluent. Other states reasoned there must be a fallacy somewhere. If the stricter limits were needed, then the less stringent requirements were ineffective. But if the less stringent requirements were all that was needed, then why the more stringent regulations? So some followed the precedent of sewage treatment requirements and called for a percentage reduction in phenol concentration. Others just bided their time. Then there were those who required "everything feasible that could be done, be done".

This confusion failed to convince many in industry, as well as in state agencies, that stringent control on phenol was either reasonable or necessary. No great movement to install phenol treatment plants resulted.

The confusion and arguments were augmented and encouraged by news that analytical methods measured not phenol alone but a whole series of organics called *phenolics* because they resulted from the method of test for phenol. The method measured things that were not phenol but did not measure all phenol-like compounds, some of which have high odor. To add to the confusion came the word that phenols are not limited to coke plant discharges, the prime objective of the early studies, but are found in mountain streams from decaying vegetation, in sewage treatment plant discharges, in the urine of rabbits and pregnant mares, in the wash off macadam roads, and in countless other sources.

This array of sources alone should

*Presented at the 1960 Industrial Wastes Conference, Purdue University.

have caused a new look at the phenol problem. It would even seem logical that it could effectively silence the advocates of a zero phenol limit control. For what is accomplished, if all phenol is removed from coke plant discharges and the stream continues to carry phenol from other sources, including nature? In the interests of justice and consistent with the reasoning used to justify effluent standards that would require everyone to provide the same degree of treatment, all discharges of phenol should be included in the prohibition. The obvious impossibility of controlling some should argue for relief for the others.

However, the only regulation that provided a basis to show that a discharge was not responsible for medicinal taste due to phenol was the one that prohibited any phenol in the effluent.

Data from different water treatment plants showed a consistent inconsistency. Strong medicinal odor occurred when the phenol concentration was 2 parts per billion, and even at times when there was no measurable phenol concentration. Yet, at times when the phenol concentration was in excess of 50 ppb there was no reported taste or odor.

If a medicinal taste could develop at a water plant at concentrations equal to or below the sensitivity of the method for phenol, then the only guarantee a given discharge did not cause taste due to phenol would be to provide zero phenol in that discharge. If there could be relatively high concentrations of phenol at a water plant with no taste or odor, what is the justification, either economic or moral, for requiring absence of phenol in a discharge?

Role of Phenol

It seems hard to believe, with our National bent on collecting reams of data routinely on trivia as well as on important items, all of which are averaged and filed, there should be an exception in the case of phenol. Phenol, the "bad boy" in the operation of water plants, was measured only when trouble occurred. When there was no trouble, phenol was ignored. Other analytical tests were daily routine.

So, when the data were analyzed, the lowest concentration of phenol found at the time of trouble was judged guilty of causing trouble. Whether it was guilt by association or guilt due to responsibility was not considered.

The analysis also failed to note whether there were any other changes in water quality or characteristics coincident with the bad tasting water. There was a single-minded correlation intended. There was no need to look further because the answer to the question, *Why?* that had been accepted, was that phenol causes taste and odor.

This smug complacency of sanitary engineers and chemical engineers who were busy designing facilities to destroy phenols at water and waste treatment plants, and of chemists who professed to know water treatment plant operation, was rudely shocked by news that a steel company working with a nearby water treatment plant had shown phenol present on 191 of 197 consecutive days with medicinal or chemical tastes reported on only 25 days. The shock was aggravated by the additional information that there was no correlation between phenol concentration and taste trouble.

NOW, JUST WHAT IS PHENOL'S ROLE in the story of water pollution?

The data were developed because a Philadelphia lawyer had to be shown what everyone else supposedly knew. It is a sad commentary on the sanitary engineering profession, but one more illustration of an age-old adage: *we couldn't see the forest because of the trees.*

But the news startled the profession sufficiently to introduce a new reasoning process. The question, *Why?* was raised again. Why was there so much emphasis on phenol? Then the answer was obvious: to protect water supplies from taste and odor. Two further questions were immediately apparent:

1. What is the role of phenol in taste and odor control?
2. Will control of phenol alone protect water supplies from all taste and odor trouble?

These questions were not apparent to all immediately. Since it was a steel company, the Youngstown Sheet and Tube Company, that had done the analytical work, there was open reluctance by many in both regulatory agencies and the water industry to accept it on any other basis than as an effort on the part of the company to avoid the cost of installating additional treatment facilities. It was considered an act to sabotage the accepted pollution abatement programs.

The data had been offered *in toto* as the findings at a single water plant (Beaver Falls, Pa.) with the suggestion that other plants be checked to confirm or refute the findings. Rather than make a field check, the groaners and critics resorted to the proposition, based on the long-standing answer to the question, *Why?*, that since phenol causes trouble, it should be controlled and after that is accomplished other compounds would be considered. The objectors had difficulty apparently in recognizing there is a difference between saying "phenol causes trouble" and "phenol under certain limited conditions can cause trouble". Their proposition offered no solace to the water plant that suffered from non-medicinal type odors.

There were some notable exceptions to this reaction. The State of Ohio, for example, offered every encouragement to the steel company to find answers to the questions. It shared with the Beaver Falls water company the concern over troubles at the water plant and knew that, until the troubles ceased, Ohio and its industries would be subject to criticism. Republic Steel Corporation, Koppers Company and Sharon Steel joined forces with the Youngstown Sheet and Tube Company and the Beaver Falls water plant to develop data needed to answer the questions. New York State began to obtain data from the Niagara Falls area, and Mr. George Moore of the State Department of Health also found that there was no correlation between phenol concentration and taste trouble. He did report a high increase in chlorine demand at times of trouble. He also noted that the demand could not be attributed to phenol.

Steel companies along the Ohio and Monongahela Rivers set up rou-

tine sampling and analysis programs that measured phenol irrespective of trouble.

Added guidance came from Mr. Tom Powers of the Dow Chemical Company. He had learned that odor control was the objective, not phenol control, and he had learned that odor could be considered and measured as an entity. He also investigated the chemistry of chlorine-phenol reactions.

What Were the Findings?

These activities were directed towards obtaining data to answer both questions, but with a change in emphasis. The role of phenol in taste and odor control was now incidental to the desire to learn whether taste and odor control *per se* was feasible. If odor could be considered an entity and sources of odor traced without necessity for detailed chemical analyses, (that are yet to be developed), a major breakthrough in pollution abatement would be accomplished. The forty years of work on phenol as a contaminant would not have to be duplicated for every distinct organic pollutant. A myriad of analytical procedures would not be needed. Volumes of regulations limiting concentrations would not come into being, and relief for water plants would not have to wait for the hazy and distant future.

But there still existed that core of experts who argued that since there are phenol limits on the books, controls must be instituted. For their benefit, as well as for academic advancement, the necessity to define the role of phenol remained. This group never seems to recognize there are also limitations on taste and odor, as such, on the books that should also excite controls. Since phenol is considered alone, it offers no comfort to argue that the satisfactory accomplishment of odor quality negates the need to meet phenol requirements.

The findings reported here came from work on the Mahoning-Beaver Rivers. As yet there have been no data offered by others to dispute the conclusions. The contrary has been true.

Detailed findings have been reported by this author in other papers. Rather than review them again, the generalized summary is presented.

On odor control *per se,* here are the results:

1. Odor can be considered as an entity and measured as such. The arguments advanced for so long by the USPHS and others that odor is too subjective to permit comparative measurement have been effectively rebutted by clinical testing and stream survey work. There is no argument against odor being subjective. The difference lies in application. The PHS attempted to find the sensitivity of individual responses to trace concentrations. The river survey work looked for changes in odor and causes of the changes. The river survey does not need the sensitivity of a jeweler's tools to find changes in intensity and characteristic that will be reflected by a water user.

There is an acceptable odor determination technique. It was developed by Dow. It has, subsequent to the clinical and field testing work, been recommended by the Joint Committee on Uniformity of Methods of Water Examination panel on odor. There is agreement on determining odor intensity. There is agreement that uniformity on odor characteristic is not yet feasible.

2. Changes in odor intensity at a water plant can be traced back to the cause. But it takes field work and cannot be done by directive. It takes an intimate knowledge of sources of odorous discharges and a determination of key control points that will sectionalize the river and the discharges.

3. Emphasize changes in odor. Odor troubles at all water plants are sporadic or variable in degree. All natural streams carry a base odor intensity due to the solubility of substances over which the runoff flows. This base then changes with normal discharges to it. The result may be agreeable or disagreeable. There may be variation in intensity or characteristic under either category. The base characteristic may be unpleasant and yet there can be occurrences of odor that are decidedly more disagreeable or even obnoxious. The causes of these occurrences can be traced and controlled. The work on the Beaver-Mahoning Rivers showed a base characteristic at Beaver Falls of musty, septic odor that was traced to the continuous discharges of very large volumes of raw sewage. In addition, there were occurrences of chemical odor. These were traced to several sources and control measures instituted.

But, as an illustration of how this accomplishment has been deliberately misconstrued, note the comparison made between the odor level of water at Chanute, Kansas, when that city was recycling sewage during the recent drought and the odor intensities reported at Beaver Falls (see AWWA Journal April 1960). The intimation was that the work at Beaver Falls was intended to white wash industrial discharges. Three items deserve attention. The odor levels at Chanute were made on strongly chlorinated samples after de-chlorination; at Beaver Falls the odors were reported as they actually existed. The second point: During a long work stoppage, when the majority of the upstream industrial discharges were shut off, the same base odor intensity and characteristic existed at the water plant. And third point to note is that no reference is made in the comparison to the differences in odor methods used.

4. Base odor characteristics vary too widely to permit a "cookbook" regulation to have any validity. The odor intensity of a discharge is no indication of the persistence of the odor downstream. Hence, a "cookbook" standard for an effluent is of no use if the tenet is accepted that discharge to a stream is a reasonable use of the stream as long as it does not interfere with subsequent water users. Even more, some presently acceptable means of waste treatment, such as biological oxidation of phenols, develop their own odor levels and characteristics that are immune to further stream oxidation and can be reduced only by dilution.

5. Consider not only industrial effluents but also municipal sewers and sewage treatment plants, agricultural wash, reservoir drawdowns and pipeline breaks as not only potential but actual causes of trouble for water plants. The drawdown of oil from the top of a digester, dis-

charged directly to the river, causes Beaver Falls trouble. So did the drawdown of a reservoir. The drawdown was from the bottom and it released volumes of water high in organics from decaying vegetation but low in oxygen. A pipeline break also ran into the water supply.

6. Water treatment plant operators who will conscientiously perform odor determinations and who will work with upstream sources of waste can develop a knowledge of characteristic effects and potential sources. Most companies will cooperate in such activity. Cities will also cooperate once they are alerted to their problem.

7. A river can be sectionalized with key control points, such as a water plant or industrial water intake. Notice of any trouble at one, sent to the next upstream points, will permit determination of the section of the river where the trouble originated. The odor characteristic will help to further define it, and contact at possible sources can pin it down.

8. Look for, and control, cleanouts or losses. The prime characteristic of odor trouble is that it is sporadic. Concentrate on slug discharges. Once control is obtained, an area study will determine possibilities for improving base odor intensity and characteristic.

9. Routine analysis of chlorine demand at water plants will show the influence of the upstream organic load.

10. Field work and area cooperation are vital necessities. However, most water plant operators, the targets of consumer complaints and the objectors to laxity in pollution abatement, must show more interest and develop better data if the program is to be successful.

On the subject of the role of phenol in taste and odor, here are some observations:

1. The information that 2 ppb of phenol when chlorinated will cause objectionable chlorophenol odor was based on studies wherein 100 ppb of phenol was chlorinated incrementally and the portion of maximum odor intensity diluted with odor-free water until the threshold was determined. The original concentration of phenol divided by the number of dilutions was considered to be the concentration of phenol that when chlorinated would cause trouble. The fact that direct chlorination of 2 ppb of phenol did not duplicate results was attributed to errors in analysis of phenol concentration at that level.

2. Chlorination of phenols to create chlorophenols results in a decrease in measurable phenol concentration.

3. Work by the Dow Chemical Company has shown that, when the phenol concentration is 2 ppm, stoichiometric requirements of chlorine will cause reaction to go to complete oxidation of phenol. When phenol concentration is 20 ppb, more than 100 times the stoichiometric requirements are needed.

4. Studies on phenol potential to cause trouble have been based for the most part on laboratory studies on pure compounds. The results, in terms of threshold concentrations as noted above, show only comparative data. Actual stream or water plant effects are not known.

5. Chlorine has an affinity for many substances in preference to phenol. When marginal chlorination is employed at a water plant, as at Beaver Falls, the chlorine can be consumed with no reaction on phenol. This is evidenced by: (a) no chlorophenol odor, and (b) no reduction in measurable phenol concentration.

6. Concentration of phenol at a water intake, then, is no criterion or indication that trouble will occur.

7. When a slug of organics reaches a water plant and causes an increase in chlorine demand, there may be a large increase in chlorine dosage. With the higher chlorine potential, reactions can occur with organics that will not occur with lower chlorine dosages. Under such conditions there is a greater likelihood of reaction with phenol to create chlorophenols. If the organic chlorine demand is greater than the dosage, there may be consumption of the chlorine by other organics before the chlorine-phenol reaction goes to completion. Chlorophenol odors can result.

8. The intensity of the chlorophenol odor is not dependent solely on the phenol concentration. In fact, at Beaver Falls no correlation existed. A correlation between odor intensity and chlorine demand, the measure of other organics, did exist.

PERHAPS WE CAN PROFIT FROM THIS PHENOL FRENZY

Phenol Can Provide Real Guidance

Cannot this four-decade hassle with phenol teach us that the fundamental question in any pollution control study is, *Why?* Without a knowledge of the objective or analysis of the reason, our course is without direction. The knowledge of an objective will permit coordination of chemistry, engineering and administration.

Consider these examples:

1. Definitions—Review definitions used in chemical analyses, the definitions used by administrative agencies, the definitions that start the engineer on a design problem. In few instances are the definitions expressions of fundamentals. For the most part, the definition is an analytical procedure. Every variation of the method automatically causes a change in the definition. Unless the definition is fundamental, how can there be a reconciliation of methods? Even more, with analytical groups working on modifications of methods continuously, how will they ever recognize a completed job?

2. Correlative effects—With an engineer's innate desire to reduce everything to a mathematical certainty (he calls it a criterion of design) the push for "cookbook" limits resulted. This was encouraged by administrative heads of regulatory agencies who could use such figures to define compliance. Mention of synergistic or antagonistic effects of different wastes is held by many as an attempt to impede progress. One of the big difficulties of this approach is that the criteria are administered as though each existed independently of the others. A limitation on temperature to protect fish in a stream where the pH is 3 is ridiculous. Design of a plant to reduce BOD by a fixed percentage is no guarantee that the effluent will not create a taste problem at a downstream intake. The only remedy is to resort to the question, *Why?* when treatment is considered. If the answer is to protect

stream uses, then all effects on stream uses demand evaluation. Engineering, not a "cookbook", is needed.

Chemists are guilty of the same sin. A figure in a data column seems at times to be the objective. Suspended solids, for example, are measured presumably to determine effect of a discharge on a stream. A dry weight is recorded. There is no indication of particle size, settling characteristics, density, color or other gauges of the time effect. The sad part is that too often they are not even considered. Few point up apparent inconsistencies in the data. The actual method used is usually not noted. Yet we compare data as though the figures were comparable and sacrosanct.

3. Coordinated objectives—When an aquatic biologist can report that a stream became sterile from aerial dispersion of pesticides and not even consider whether the stream is used for public water supplies, something vital is missing. There is a real need to give more than lip service to correlating the sciences in water studies. The fundamental complaint is that each field wants to direct the program and each lacks an appreciation of the others' talents. The fundamental trouble actually is that the question, *Why?* has not been asked and answered completely. The answer would show the weaknesses and talents of all.

The full utilization of our water resources requires answers to many *Why?* questions. That need should be sufficient to engender a fusion of our energies instead of their dissipation in confusion. A fusion of the phenol frenzy now will set the stage for progress in other aspects of water utilization.

AWWA 81st Annual Conference

The American Water Works Association has announced its technical and social programs for its 81st Annual Conference, to be held June 4-8, in Detroit, Mich. A record attendance of 3,500 is expected to be present when C. F. Wertz, Director of the Department of Water and Sewers, Miami, AWWA President, opens the meeting.

Cobo Hall's facilities are a feature in themselves. AWWA's 200-booth exhibit won't even begin to crowd the exhibit hall. The technical meetings will be held in the air-conditioned comfort of new and attractive meeting rooms, and all of the entertainment will be centered in one or another of the Hall's facilities.

Chairman of the Convention Management Committee is Gerald Remus, General Manager of the Department of Water Supply in Detroit. Under his guidance, all 500 of the Michigan Section's members will function as hosts and working committeemen. Responsible for the technical program is E. Shaw Cole, President, Pitometer Associates, New York, and his committee. Exhibit manager is John G. Stewart, Manager, Water & Sewage Works Manufacturers Association, New York.

Detroit Technical Program

SESSION 1 — MONDAY AM

AWWA Progress — C. F. WERTZ
Financing Water Utilities — MILTON J. REDLICH
Water Resources in the U.S. — *Senator* ROBERT S. KERR

SESSION 2 — MONDAY PM

What is Adequacy in Water Utility Operations—*Symposium Led by* GERALD E. ARNOLD
Managerial Qualifications — JACK MCCULLOUGH
Consumer Service — M. D. LUBRATOVICH
Rates — HENRY J. GRAESER
Plant Facilities — WILLIAM R. SEEGER
Accounting Practices — RALPH L. SWINGLEY
Engineering and Engineering Records — E. JERRY ALLEN
Planning — JAMES W. MACLAREN
Public Relations — JOHNIE E. WILLIAMS

SESSION 3 — MONDAY PM

Experiences With Anthracite Sand Filters — WALTER R. CONLEY JR.
Discussion — THOMAS R. CAME
The Nature of Organic Color in Water — A. P. BLACK & JOSEPH SHAPIRO
Instrumentation and Automation — ELLWOOD H. ALDRICH

SESSION 4 — TUESDAY AM

Open Session—Committee on Professional and Administrative Practice

SESSION 5 — TUESDAY AM

Mineral Salt Tolerances in Irrigation Water — L. V. WILCOX
Removal of Algae by Microfilters — A. E. BERRY
Physiological and Health Aspects of Water Quality—*Committee Report* — HERBERT O. HARTUNG
Water Quality Standard — ELWOOD L. BEAN

SESSION 6 — TUESDAY PM

Open Session—Committee on Standardization

SESSION 7 — TUESDAY PM

Water Resources and Problems of Michigan — NORMAN BILLINGS
Water Quality—*Joint Discussion*
Pathogens — BEVERLY W. MILLER
Detergents — S. KENNETH LOVE
Preventing Contamination of Our Water Resources — PAUL BOLTON
Food and Paper Processing Waste Disposal Practices — RICHARD L. WOODWARD

SESSION 8 — WEDNESDAY AM

What AWWA Does for You — JOHN W. CRAMER
Report of Committee on Aims and Objectives — FRED A. EIDSNESS
HydrologicProcesses of Water, Snow, and Ice at High Altitude — FRED A. CAMP

SESSION 9 — WEDNESDAY PM

Water Quality As It Affects Management—*Joint Discussion*
Relationships With U.S. Public Health Service — OMAR C. HOPKINS
Technical Surface Water Aspects in the Great Lakes Area — ARTHUR RYNDERS
Technical Ground Water Aspects in the Great Lakes Area — LYNN M. MILLER
A Case History of Public Relations — LEO LOUIS

SESSION 10 — WEDNESDAY PM

Colorado River Study — FLOYD E. DOMINY
Duplicate Water Storage — J. RAY HEATH
Water Supply on the Moon — HARRY &. LOWE JR.

SESSION 11 — THURSDAY AM

Open Session—Water Utility Advancement Committee

SESSION 12 — THURSDAY AM

Progress in Saline Water Conversion —*Task Group Report* — ROLF ELIASSEN
Operating Results in Four Filtration Plants in Detroit — ALBERT M. SHANNON
—*Committee Reports*

SESSION 13 — THURSDAY AM

Maintaining Quality in Distribution Systems—*Joint Discussion Led by* FRANK E. DOLSON, OSCAR GULLANS, H. C. MEDBERY, BENJAMIN C. NESIN & H. J. ONGERTH
Pressure Zoning and Maintenance of Distribution Systems — E. S. MAMRELLI
Right-of-Way Acquisition — HENRY J. GRAESER

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Theory and Practice of Activated Sludge Process Modifications

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■ THE PAST DECADE has seen increased interest in the application of the activated sludge process to the treatment of sewage and industrial wastes. In order to increase the efficiency of the process and reduce capital and operating costs, various process modifications have been developed. Research advances on the mechanism of the process have led to improved design methods. It is the purpose of this paper* to review these recent developments as they apply to several modifications of the activated sludge process and to discuss recent performance data from these processes.

Mechanism of the Activated Sludge Process

When an organic waste is contacted with biological sludge, BOD is removed by several mechanisms. Suspended and finely divided solids are removed by adsorption and coagulation. A portion of the soluble organic matter is rapidly removed by absorption and stored in the cell as a reserve food source. Additional dissolved organic matter is progressively removed during the aeration period resulting in the synthesis of sludge and the production of carbon dioxide and water. The rate of BOD removal after initial absorption depends primarily upon the concentration of BOD to be removed and the concentration of active sludge solids. The reactions involved in the removal of soluble BOD from solution during bio-oxidation can be interpreted as a three-phase process:

a. An initial removal of BOD on contact of a waste with a biologically active sludge which is stored in the cell as a reserve food source.

b. Removal of BOD in direct proportion to biological sludge growth.

c. Oxidation of biological cellular material through endogenous respiration.

At high BOD concentrations the rate of BOD removal is independent of concentration and is directly proportional to the concentration of activated sludge present. BOD removal under these conditions is exposed by Equations 1 and 2, Table 1. At low BOD concentrations, the rate of removal becomes BOD concentration dependent and removal becomes directly proportional to both the concentration of activated sludge solids and the BOD remaining in solution. Wuhrmann, et al,[18] has shown that the rate of removal of simple specific compounds is usually linear with time and sludge solids concentration to very low substrate levels, less than 1 ppm. The kinetics of these reactions are explained by the laws governing enzymatic reactions. The removal of phenol by activated sludge appears to follow this linear relationship. The complex nature of sewage and many industrial wastes causes a decreasing BOD removal rate as oxidation proceeds since the various waste components differ in the ease with which they are oxidized. In some waste oxidation systems this results in long detention period requirements for high BOD removal. The mathematical relationships governing BOD removal and sludge growth for various operating conditions have been formulated by several investigators[1 2 3 4]. The relationships are summarized in Table 1. The BOD removal and sludge growth relationships are schematically shown in Figure 1.

Four modifications of the biological sludge process will be discussed in this paper namely, the conventional activated sludge process, the contact-stabilization process, total oxidation and the aerated lagoon.

Conventional Activated Sludge

In the conventional activated sludge process, waste is mixed with biological sludge and aerated for a predetermined period. The aerated sludge-liquid mixture is then separated by sedimentation and the settled sludge returned for admixture with fresh waste. The aeration period is determined by the BOD of the waste, the concentration of mixed liquor solids and the desired BOD removal efficiency.

In the case of low BOD wastes, e.g., sewage, paper mill wastes, etc., the process usually operates over the range B-C (Fig. 1). This requires an aeration detention period of t_1 and results in a sludge accumulation of ΔS_2. The mathematical relationships governing BOD removal under these conditions is shown by Equations 3—7 in Table 1. Conventional activated sludge treatment of domestic sewage usually operates over a BOD loading range of 0.2—0.4 lbs BOD/day/lb aeration solids[5]. For aeration solids levels of 2000 ppm this requires aeration detention periods of 4—6 hours. A major part of the BOD is removed in the first few minutes of aeration by biosorption and flocculation. Oxidation and synthesis occur during the remainder of the aeration period. Since oxygen utilization is intimately associated with BOD removal and sludge growth, the oxygen demand rate curve will approximately follow the BOD removal curve. In the conventional process this results in a high initial demand rate followed by a rapid decrease to the endogenous rate toward the end of the aeration period. For average sewage strengths the oxygen uptake rate will vary from 60 ppm/hr at the head end of the aeration tank to approximately 15 ppm/hr at the outlet end. Tapered aeration is necessary to follow this demand rate curve.

*Presented at 1960 Annual Meeting, Michigan Sewage and Industrial Wastes Assoc.

Table I
Summary of Biological Oxidation Kinetics

Condition	BOD Removal Equation	Remarks
1. High BOD Wastes	$2.3 \log\left(1 + \frac{aL_r}{S_a}\right) = K_1 t$	applicable when the initial BOD/sludge solids ratio exceeds 2; applies only when BOD removal is independent of BOD concentration (usually) at BOD levels above 200-300 ppm.
2. High BOD wastes	$\frac{L_r}{t} = \frac{K_1 S_a}{a}$	applicable when initial BOD sludge ratio is less than 2. Same limitations as equation (1)
3. Low BOD wastes	$\frac{L_r}{L} = \left(1 - e^{-K_2 S_a t}\right)$	describes course of BOD removal for single substrates with initial BOD's less than 300 ppm.
4. Complex wastes	$L = L_a e^{-(K_2)_a t} + L_b e^{-(K_2)_b t} + L_n e^{-(K_2)_n t}$	
5. Complex wastes	$-\frac{dL}{dt} = \frac{K_2}{(1 + mt)} L$	Equations 4, 5, and 6 estimate BOD removal from complex waste substrates in which the removal rate decreases with time or concentration
6. Complex wastes	$-\frac{dL}{dt} = K_2\left(\frac{L}{L_a}\right)^n L$	
7. Complete mixing	$\frac{L_r}{L} = -\frac{dl}{dt}\left(\frac{t}{L_a}\right)$	defines removal from completely mixed aeration tanks

Nomenclature: a — fraction of BOD removed converted to sludge
K_1 — sludge growth rate constant
K_2 — BOD removal rate constant
L_a — initial BOD concentration
L_r — BOD removed
m, n — retardent constants
S_a — average sludge solids concentration
S_o — initial sewage solids concentration
t — time

Process modifications such as step aeration in which the sewage is added to the aeration tank in increments down its length or complete mixing in which the sewage is added along the length of the aeration tank will equalize the oxygen demand throughout the aeration tank at its mean rate. This will insure more uniform distribution of oxygen and maintenance of dissolved oxygen.

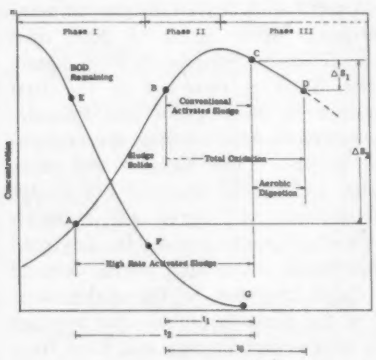

Fig. 1. SCHEMATIC OF the activated sludge process.

Mixed pulp and paper mill wastes have been treated by the conventional process at the West Virginia Pulp and Paper Company, Covington, Va.[6] for several years. Recent operating data are summarized below:

Average Performance for Nov.-Jan., 1960
Activated Sludge Plant—
West Virginia Pulp & Paper Co.,
Covington, Virginia

Flow, mgd	21.0
BOD, ppm	188
Suspended solids, ppm	122
lbs BOD applied/day/lb aeration sludge	0.67
Mixed liquor suspended solids, ppm	2280
Sludge volume Index	286
Recycle sludge (%)	30
Aeration Detention, hrs.	2.3
% BOD removal	84
lbs N/100 lbs BOD removed	3.4
lbs P/100 lbs BOD removed	0.7

BOD removal from this waste follows a retardent reaction whereby 65—75 per cent of the BOD is rapidly removed from solution in the first hour of aeration and the remainder at a progressively decreasing rate. BOD removals in excess of 85—90 per cent consequently require long aeration detention periods. The mean oxygen utilization was found to vary from 35.3 ppm/hr/1000 ppm sludge at the influent and of the aeration tank to 8.9 ppm/hr/1000 ppm sludge at the effluent end. BOD removal relationships from a mixed pulp and paper mill waste are shown in Figure 2.

In the case of high BOD wastes (BOD> 500 ppm), the process operates over the range A—C (Fig. 1). For high BOD removals the detention period is increased to t_2 and the excess sludge accumulation to ΔS_2. Down to a limiting concentration of BOD, the BOD removal is approximately linear with sludge concentration and time, (E-F) Fig. 1; Equations 1 and 2, Table 1. Below this BOD concentration the rate of removal is concentration dependent. The oxygen utilization rate will remain at a constant or a slightly increasing value over the range E—F. Below point F, Figure 1, the uptake rate will rapidly decrease and level out at the endogenous rate. In the treatment of pharmaceutical waste[7] the BOD removal rate averaged 200 ppm/hr/1000 ppm sludge to a limiting concentration of approximately 400 ppm. At lower concentrations the removal rate progressively decreased. In the treatment of phenolic wastes with an initial phenol concentration of 800 ppm, by the activated sludge process, the removal rate of phenol averaged 0.75 lbs phenol removed/day/lb aeration sludge. This removal

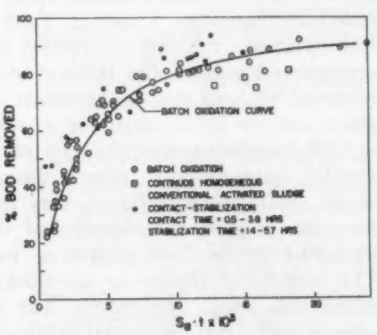
% BOD REMOVED
BATCH OXIDATION CURVE
BATCH OXIDATION
CONTINUOS HOMOGENEOUS CONVENTIONAL ACTIVATED SLUDGE
CONTACT-STABILIZATION
CONTACT TIME = 0.5 - 3.0 HRS
STABILIZATION TIME = 1.4 - 5.7 HRS

Fig. 2. BATCH AND continuous oxidation relationships at low BOD concentrations.

was linear with time and aeration solids. The sludge accumulation in the process was 0.16 lbs VSS/lb phenol removed.

Oxygen utilization rate will remain at a constant or a slightly increasing value over the range E—F. Below point F, Figure 1, the uptake rate will rapidly decrease and level out at the endogenous rate. In the treatment of a pharmaceutical waste[7], the BOD removal rate averaged 200 ppm/hr/1000 ppm sludge to a limiting concentration of approximately 400 ppm. At lower concentrations the removal rate progressively decreased.

Contact Stabilization

When a high percentage of the BOD is rapidly removed by biosorption after contact with well aerated activated sludge, the contact—stabilization process can be advantageously employed. In this process waste is aerated with stabilized sludge for a short contact period, usually 30—60 minutes. The mixed liquor is then separated by sedimentation. The settled sludge is transferred from the clarifier to a sludge stabilizer where aeration is continued to complete the oxidation and to prepare the sludge for BOD removal from fresh incoming waste. The process is schematically illustrated in Figure 3.

When the BOD removal rate is too low to attain the desired overall BOD removal in a short contact period, the aeration contact period can be extended to attain the additional desired removal. This additional removal is indicated in Figure 3.

The magnitude of the initial removal is dependent on the conditions of the sludge when it is in contact with waste and on the waste characteristics. If the sludge has had an insufficient period of aeration prior to contact with waste, previously stored BOD will not be completely metabolized and the initial removal will be reduced. Results reported by the Water Pollution Research Laboratory[8] showed that ½ hour aeration after contact of sewage with sludge resulted in a progressive loss of clarifying power while two hours aeration maintained a continued high degree of clarification. On the other hand, excessively long sludge aeration periods result in extensive endogenous respiration and resulting loss in BOD removal capacity of the sludge. Wuhrmann[9] demonstrated a rapid reduction in the removal rate of lactose by activated sludge with sludge aeration periods up to 216 hours. The relation between sludge aeration or stabilization time and BOD removal for various contact periods is shown in Figure 3. The data in Figure 3 were obtained by aerating sludge with a mixture of domestic sewage and textile mill waste for 15 minutes, separating the sludge, and aerating the sludge with waste for 0.25, 1.0 and 1.5 hours after the indicated stabilization periods. It is apparent from Figure 3 that for a contact period of 0.25 hours, a stabilization period of 2—6 hours is necessary to maintain the BOD removal capacity of the sludge. Increasing the contact period to one hour permits some oxidation of the absorbed BOD and reduces the stabilization requirement to 1 hour.

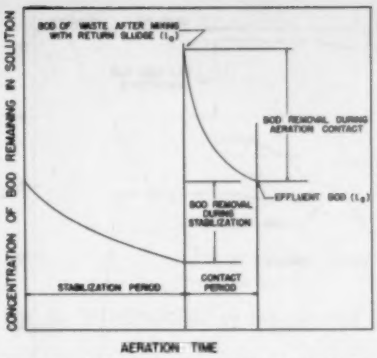
BOD OF WASTE AFTER MIXING WITH RETURN SLUDGE (L_0)
BOD REMOVAL DURING AERATION CONTACT
EFFLUENT BOD (L_e)
BOD REMOVAL DURING STABILIZATION
CONTACT PERIOD
STABILIZATION PERIOD
CONCENTRATION OF BOD REMAINING IN SOLUTION
AERATION TIME

Fig. 3. SCHEMATIC OF contact-stabilization process.

The required stabilization period will depend on the magnitude of initial BOD removal and on the contact detention period. Increasing the contact period permits some oxidation of absorbed organics and reduces the required stabilization period. A substantial increase in the contact period will permit complete oxidation of the absorbed organics and eliminate the need for stabilization. This is then a conventional activated sludge process. Increasing the concentration of mixed liquor suspended solids will decrease stabilization requirements for the same BOD loading since the BOD removal per unit sludge mass will be reduced. Under these conditions less time is required for the oxidation of the absorbed BOD in the stabilization tank.

The contact stabilization process has been employed for the treatment of domestic sewage at Austin, Texas[10] and Bergen County, New Jersey[11]. Pilot plant and full scale plant studies were reported employing this process for the treatment of cannery wastes[12]. High BOD reductions have been reported in the application of this process to the treatment of pulp and paper mill wastes[13]. BOD reductions in excess of 85 per cent have been found in the treatment of a mixture of domestic sewage and textile wastes[14]. The performance of the contact-stabilization process treating these wastes is summarized in Table 2.

Total Oxidation

Total oxidation, by definition, is a process so designed that the biological sludge produced by synthesis is consumed by auto-oxidation. In or-

Table 2
Performance of the Contact-Stabilization Process

		Detention, hrs.		Suspended Solids, ppm				
Waste	BOD	Contact	Stabilization	Contact	Stabilization	% Recycle	% BOD Reduction	Reference
Sewage	264	0.24	1.60	3251	5218	100	02.5	—
Sewage	108	1.30	4.25	2239	8629	44	88.0	11
Sewage	210	0.18	1.00	2500	4500	100	90.0	11
Sewage and Textile Mill	225	0.60	5.50	2950	6950	67	77.0	14
Sewage and Textile Mill	320	1.10	3.30	3200	7900	71	86.0	14
Pulp & Paper	249	0.50	3.70	6360	—	25	72.0	13
Pulp & Paper	191	1.00	4.0	4642	—	100	87.0	13
Pulp & Paper	218	2.00	2.0	5980	—	25	93.0	13
Tomato cannery	412	0.80	1.6	2250	3600	100	85.0	12
Tomato cannery*	450	0.35	1.65	2250	4500	125	84.0	12
Tomato & apple	492	1.00	2.00	2500	4400	100	89.7	12
Peach & tomato	740	0.65	1.30	3600	5900	100	58.0	12

*Aero-Cyclater Stabilizer Pilot Plant

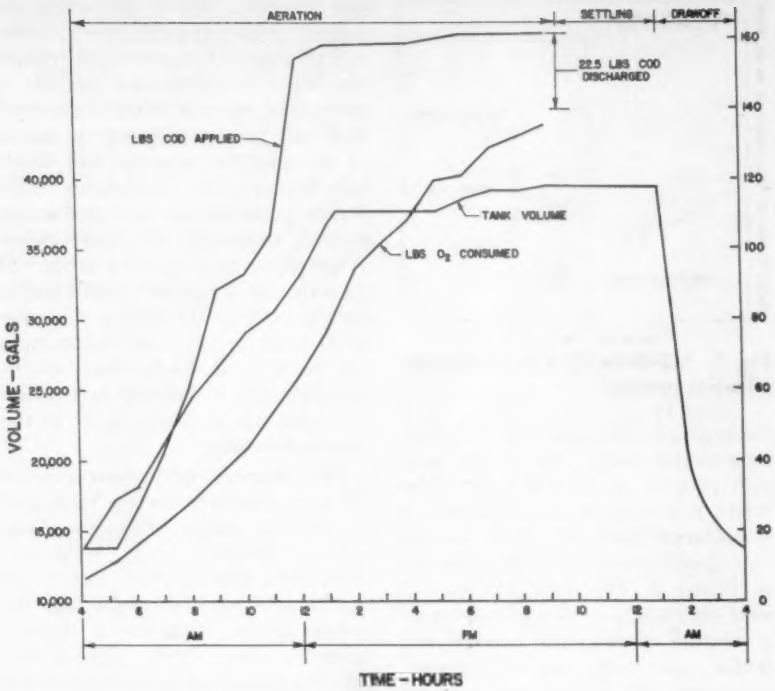

Fig. 4. BATCH TREATMENT of dairy wastes.

der to accomplish this oxidation, the aeration detention period must be increased from t_1 to t_3 (Figure 1). The process then operates over the range B—D and the sludge accumulation, Δ s theoretically approaches zero.

In practice, it has been shown that the auto-oxidation of biological sludge does not follow first order kinetics, but rather follows a retardent reaction in which the rate of oxidation decreases with time or concentration. This is because of the various cellular constituents differ in their ease of oxidation. A portion of the cellular material is highly resistant to oxidation and results in an accumulation in the process. McKinney[15] and Kountz et al[16] have indicated that the non-oxidizable solids build-up from the auto-oxidation of biological sludge may amount to 25 per cent of the sludge formed. If non-oxidizable suspended solids are present in the incoming waste the solids build-up will be greater. In small installations, this excess sludge accumulation can be removed at intermittent intervals by tank truck.

The total oxidation process can either be designed as a continuous system in which the aeration detention period is usually 24 hours or as a batch fill and draw system. The batch system is most adaptable to industrial wastes of sewages in which the total waste flow is received over 8—12 hours. The operation of a batch system involves aeration, settling and decantation from a single tank. This sequence of operations for a dairy waste is shown in Figure 4.

Since the detention period required for BOD removal is considerably less than that required for auto-oxidation, the tank volume will be controlled by the sludge oxidation rate. The following procedure can be employed to determine design criteria.

The sludge balance in the aeration tank can be approximately expressed by the relationship:

$$\Delta S = aL_r - b \int a \qquad (8)$$

in which ΔS = increase in biological sludge solids in lbs/day.

a = fraction of BOD synthesized to sludge. This usually varies from 50—75 per cent of the 5-day BOD removed.

L_r = BOD removed, lbs/day.

b = mean rate of auto-oxidation, fraction per day. For soluble substrates such as dairy wastes, b, will average between 15—25 per cent per day at 25°C. Wastes containing suspended solids of a low oxidation rate such as domestic sewage may have endogenous rates of 6—12% per day.

S_a = average mixed liquor suspended solids, lbs.

Equation 8 does not consider the inert fraction of sludge which is not oxidized in the process. In the total oxidation process $\Delta S \cong 0$ and Equation (8) becomes:

$$aL_r = bS_a \qquad (9)$$

The quantity of sludge which must be maintained under aeration in order to approach total oxidation is

$$S_a = aL_{r/b} \qquad (10)$$

The application of Equation 10 can be illustrated by the following example:

Design a total oxidation plant to treat 26,000 gpd of a dairy waste containing 161 lbs COD over a period of 17 hours. The mean auto-oxidation rate of the sludge is 24 per cent per day. The COD reduction is 90 per cent.

COD removed/day = 0.90 x 161
= 145 lbs/day

Equilibrium quantity of sludge

$\Delta S_a = aL_r - bS_a$

$\Delta S_a = 0$

$aL_r = bS_a$

If the constant *a* for dairy waste is 0.5 and if aeration proceeds for 17 hours then

$$(0.5)\ (145) = 0.24 \frac{17}{24} - S_a$$

$S_a = 430$ lbs

If the sludge occupies 0.8 cu ft/lb the required sludge volume is

(0.8) (430) = 344 cu ft

The waste volume is 26000/7.48
= 3500 cu ft

Sludge free board = 172 cu ft

Total tank volume = 4016 cu ft

Since in the total oxidation process the sludge produced by synthesis is consumed by auto-oxidation, the oxygen requirements are greater than the conventional process. For the case of complete sludge oxidation the total oxygen requirements will approximately equal the ultimate BOD.

Aerated Lagoons

An aerated lagoon can be defined as a lagoon of significant depth in which aerobic conditions are maintained by mechanical or diffused aeration. While the activated sludge process employs high biological solids and short aeration periods, the aerated lagoon requires long detention

periods and employs very low solids concentrations. The aerated lagoon is schematically shown in Figure 5. The purification capacity of an aerated lagoon is comparable to that in natural streams since the solids and turbulence levels are of the same order of magnitude[17].

Since the biological sludge solids concentration is very low, BOD removal is primarily a function of detention time. Data obtained from several experimental lagoon installations are shown in Figure 6. Performance data are summarized in Table 3. The oxygen requirements in an aerated lagoon are directly proportional to the BOD removed. Because of the long retention period, much of the sludge produced by synthesis is consumed by auto-oxidation. Several systems studied showed the oxygen requirement to vary from 0.9—1.2 times the 5-day BOD removed.

Oxygen is transferred to the lagoon contents from the atmosphere through surface turbulence and from mechanical or diffused aeration systems. In most cases approximately 25 per cent of the required oxygen is transferred through the surface and the remainder by the aeration system. It is the writer's opinion that mechanical aeration systems afford a more economical initial installation and a reduced maintenance cost. Most mechanical surface aeration systems on the market today can be expected to transfer 2.5—3.5 lbs O_2/hp-hr. Based on an oxygen demand rate of 1.1 lbs O_2/lb BOD removed and 2.5 per cent surface aeration, the power requirements for lagoon aeration may be expected to vary from 0.24 —0.33 hp/lb BOD removed.

Summary

Biological waste treatment facilities cover a wide spectrum of process applications, from the aerated lagoon with long retention periods and low solids to the high rate activated sludge process with short aeration periods and high aeration solids. The selection of method depends primarily on the characteristics of the wastes, geographical location and the effluent requirements of the regulatory agency. The advantages and disadvantages of the process modifications described in this paper are summarized below:

Aerated Lagoons—require large land areas with retention periods usually ranging from 4—7 days; low capital and operating cost with the major operating cost in power for aeration, capital cost approximately ⅔ that for activated sludge; sludge disposal by basin dewatering after long periods of operation; BOD removals usually vary from 75 —85 per cent during summer operation and 50—60 per cent during winter operation without nutrients; high effluent suspended solids unless settling area provided.

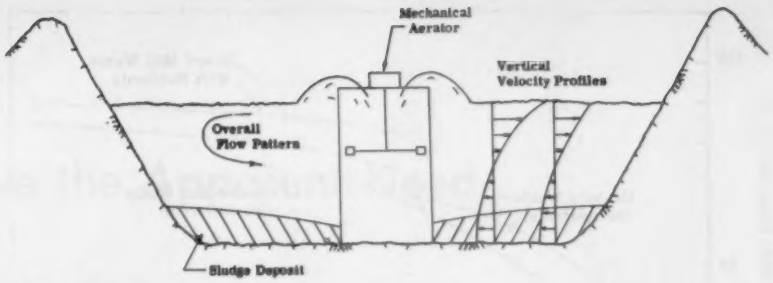

Fig. 5. SCHEMATIC of the aerated lagoon.

Conventional Activated Sludge —compact installation with retention periods varying from 2—6 hours for low BOD wastes and up to 24 hours with high BOD wastes. High capital and operating costs; separate sludge handling and disposal facilities required; high BOD and suspended solids removals in summer and winter.

Table 3
Aerated Lagoon Performances

Waste	ppm	Det'n days	Temp. °C	% Reduction
Pulp & paper (without nutrients)	210	1	27	33
	250	2	23	42
	250	2	20	48
	200	3	31	72
	250	4	15	64
	290	4	20	59
	260	4	25	62
	210	4	30	81
Cannery (without nutrients)	580	5	25	71
	550	4	25	65
	890	3	26	60
	840	2	26	59
	605	1	24	43
Board mill (without nutrients)	457	3	23	81.3
	465	5	"	87.4
	452	7	"	89.1
Board mill (with nutrients)	457	3	23	78.0
	465	5	"	86.5
	452	7	"	88.7

Contact—Stabilization—depends upon high initial removal capacity of sludge with waste being treated; aeration contact periods range from ½—2 hours depending on initial removal capacity and degree of treatment desired. Sludge stabilization periods vary from 2—6 hours depending upon contact time, solids levels and BOD loading; separate sludge handling and disposal facilities required; operating costs comparable to conventional activated sludge.

Total Oxidation—requires long aeration periods to oxidize biological sludge. BOD removals comparable to conventional activated sludge; minimal sludge handling facilities; economically favorable for low waste volumes.

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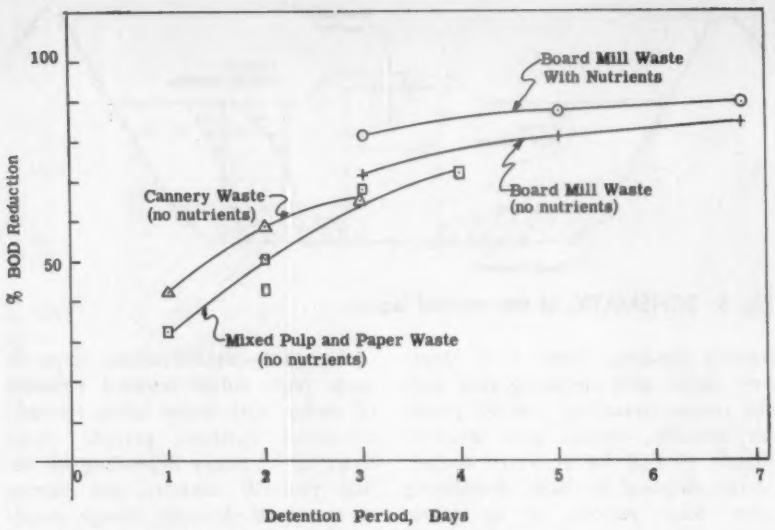

Fig. 6. AERATED LAGOON performance (temp = 25°C).

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Proceedings of National Water Conference Available

The Proceedings of the National Conference on Water Pollution, held in Washington, D. C., last December 12-14, are now available in full and complete form (PHS Publication Number 819).

The document of more than 600 pages includes: (1) all major addresses presented at the opening and closing plenary sessions; (2) comments of members of Congress who served on a panel the evening of the Conference banquet; (3) complete reports of the subcommittees representing each of the panels; (4) the public floor discussions accompanying each report; (5) recommendations of the Conference; and (6) appendixes.

The four panel themes ,which were discussed concurrently and at length, were: I—Water Pollution And Our Changing Times: Effects of Pollution on the National Health, Welfare, and Economy; II—Meeting The Growing Competition For Water: Pollution Control as a Means of Increasing Water Supplies; III—Keeping Water Clean: Responsibilities of Government, Industry, and the Public; and IV—Research And Training: Critical Needs for Research, Resources, and Training.

Single copies are available on a complimentary basis from a limited supply. They are on sale from the Superintendent of Documents, Washington 25, D. C., at $2.25 per copy.

Ferry Joins Metcalf & Eddy

Mr. John M. Ferry, until recently Special Assistant for Installations to the Secretary of the Air Force, has joined the staff of Metcalf and Eddy, Consulting Engineers of Boston.

In 1956, Mr. Ferry was presented the Exceptional Civilian Service Award for outstanding service to the Air Force. He has had the overall supervision of a construction program totaling more than a billion dollars, including such major items as air bases in Spain and the Air Academy. His efforts have been regarded as a major contribution to the marked improvement in the Air Force construction program.

Oklahoma City Prepares New Water Rates

A new schedule of water rates for Oklahoma is being prepared with a view toward applying the cost of a $63 million Atoka pipeline equally to water users both inside and outside the City according to the amount of water used.

City Manager, Sheldon L. Stirling, said that the proposed schedule would require suburbanite customers to continue paying an extra charge in lieu of taxes as well as the increased rate for financing the Atoka project. The new schedule is based on a 50 per cent increase in rates, a boost recommended by engineers for the financial group which purchased the bond issue.

Maine Water Utilities Association Journal, October, 1960

The Thirty-First Annual Meeting of the Maine Water Utlities Association was held at Madawaska, Maine in October, 1960.

The focal point for the forenoon of the first day was Madawaska's newly completed filter plant designed for compact and efficient operation. Following the business of the meeting, J. U. Wiesendanger of East Winthrop, Maine, Consulting Engineer, described the design and operation of the new plant.

Oscar Webb of Bangor presented a discussion of Group Life Insurance followed by William P. Coues of the Boston Safe Deposit and Trust Co. who outlined the part that trust companies play in safeguarding the assets of group trust funds.

Editorial

Dissolve the Apparent Need

At least four significant pronouncements have been made in recent months which could have effects, both good and bad, on the future of water resource conservation and pollution abatement programs.

In November, the respected Abel Wolman counseled the Eastern Water Company Conference about the Impact of Desalinization on the Water Economy (JAWWA February, 1961). He supported his premise that perhaps excessive emphasis is being placed on the possible panacea of sea water conversion with regard to water shortages. He also provided data which could cast doubt on extrapolated cost calculations now extant. If Dr. Wolman's usually capable analyses carry over into this area, let those who release vital data on the subject heed Dr. Wolman's reminder that "average figures . . . tend to conceal the fact that some areas in the United States will encounter water difficulties earlier and to a greater degree than others".

In December, the 15th Engineering Conference of the Technical Association of the Pulp and Paper Industry meeting in Jacksonville, Florida, heard Mellon Institute's Richard Hoak decry worrisome pronouncements of impending water shortage. The point of his remarks seemed to be that some of the conclusions drawn by students of water supply, treatment, distribution and use do not indicate the need for a crash program of conservation. Dr. Hoak sees no cause for national alarm.

The Water Pollution Control Federation's massive statement of policy reached most of us for real study in December. It deals rationally with wastewater collection, treatment, and disposal. Substantial emphasis is placed by the Federation on the *status quo* regarding shared responsibilities and continuation of USPHS as the Federal administrative agency. Mandatory operator certification is believed to be the "best ultimate means of assuring the most effective operation and maintenance of pollution control facilities".

Finally, the ponderous text, "Water Supply, Economics, Technology, and Policy"* points up several areas which should be of consummate interest to resource doers and thinkers everywhere. Exhaustive economic analyses of California's water plan and New York's supply development program have been made by the authors. Indications are that touchy areas of controversy have been treated lightly by the planners of both programs. Statements published by the authors suggest faulty economic analysis on several counts in these two tremendous areas of interest.

These few samples of extremes may not amount to much standing by themselves. However, coming as they do from renowned and experienced sources at this precise time could result in considerable impact. In the case of Drs. Wolman and Hoak, words from them may be considered cautionary to those among us who might tend to over-dramatize. There is a danger, though, that these words of caution might be misunderstood by the non-technical public whose sympathy and concurrence with projects in our area are difficult to earn. Indeed, such misunderstanding could undermine years of planning and dedicated effort at Federal, state, and local levels. And this could be catastrophic.

The Federation's statement of policy fundamentally tries to establish a framework which perhaps unintentionally meets objections raised in the Hirshleifer, *et al.* book. There's a real lesson to be learned from the book, research for which was supported by the Rand Corporation. Though criticism was leveled by the authors at the two major water supply projects, the lesson for all appears obvious. As public information and other mass stimulation efforts penetrate the public mind, all water supply, conservation, and pollution abatement projects will be subject to increasing scrutiny, economic and otherwise. The prime target of this scrutiny will be the local official. He will, therefore, be well advised to prepare himself in advance for an onslaught of queries. His preparation must necessarily include complete and utter justification of his present public support program. To this end, he will study, tighten up the sewage collection or water distribution system, improve operating efficiency, and otherwise use all known techniques to eliminate flaws. Attention to such details might possibly dissolve the apparent need for some projects now under consideration.

V. W. Langworthy

*Hirshleifer, DeHaven and Milliman, The University of Chicago Press, Chicago, Illinois (1960).

HYPOCHLORINATION GUIDE

Author's Note:

The previous articles in this series pertained to the nature, manufacture, storage and handling of hypochlorites, and the principles involved in the use of hypochlorites in potable water and wastewater treatment. It was indicated that: applications of hypochlorites for sanitary purposes must be carefully controlled in order to accomplish the treatment objective; where disinfection is necessary to insure water potability or, in some cases, to comply with stream or other water-use quality criteria, the process must be continuous; of the several grades and proprietary forms of hypochlorites available, those most adaptable to sanitary applications are (1) "high test" granular, powdered or compressed (tablet) calcium hypochlorite and (2) sodium hypochlorite solutions.

This article, concluding the series, pertains to equipment used for dispensing hypochlorites for disinfection and other treatment objectives. References to proprietary chemical feeders are necessarily brief and are intended only for illustrative purposes. Such references do not signify product endorsement by the Institute; similarly, it should not be inferred that the absence of reference to numerous other proprietary feeders signifies limited or no usefulness for applying hypochlorites.

Hypochlorite Feeding Equipment

Part IV

by EDMUND J. LAUBUSCH,
The Chlorine Institute, Inc.,
Technical Manager
New York, N.Y.

Hypochlorite Application

Hypochlorites can be applied to potable, wastewater or other sanitary systems in various ways depending on the nature, objective and continuity of treatment and on the form of hypochlorite employed. Hand dosing is the crudest means of application but it may suffice for many specialized purposes, especially those involving only occasional or one-time use. Such instances might include disinfection during well-drilling operations and construction or repair of piping systems or appurtenances, for cleaning reservoirs, for cleaning or increasing well capacity, for algae, psychoda fly or odor control, for disinfection or algae control of wading and other small pools, etc. Hand dosing, at best, is haphazard, involving the human element, uneven hypochlorite distribution, and only approximate control of chemical dosage. Where possible, the use of even the simplest chemical feeder is the preferred means of application. In all cases, thorough mixing of an adequate amount of the hypochlorite with the solution to be treated is essential, and contact time sufficient to insure the treatment objective must be provided.

Fundamentally, there are two basic classes of chemical feeders: (1) dry feeders, in which the chemical is received, measured and dispensed in dry form, e.g., granular or powdered high test calcium hypochlorite; and, solution feeders, in which the chemical is received, measured and dispensed in solution. High test calcium hypochlorites can be applied either through dry feeders or through solu-

Addenda. The following table is a correction and addition to the "Table IV" that appeared in Part II of this Hypochlorination Guide series. (W&SW, Aug. 1960, p 326).

Table 4

Disinfection Processes at U.S. Water Plants Serving 25,000 or More Persons[2,4,8]

Year	Number of Plants			Chlorine Forms Employed				
	Total	Employing Disinfection	Using Chlorine	Hypochlorite	Gas	Both	Not Specified*	Disinfectant Unknown, or Other Than Chlorine
1948	480	465	443	2	243	4	194	21
1956	591	579	541	13	388	12	141	25
1958	635	622	590	14	425	15	136	32

*Involves chlorine and ammonia treatments; chlorine form used not stated

Ref. 8. Statistical Summary of Municipal Water Facilities Communities of 25,000 Population and over, as of January 1, 1958. U. S. Dept. of Health, Education, and Welfare, Public Health Service.

tion feeders; sodium hypochlorite can be applied only through solution feeders because dry forms are not commercially available.

There are a variety of proprietary dry and solution chemical feeders that are suitable for, or can be adapted to, applying hypochlorites. In addition, many home made devices can be effectively utilized for some purposes. The utility of all feeders must be evaluated on the basis of dosage control afforded in relation to that desired or needed, ease of operation and maintenance, the degree of supervisory control available or necessary, capacity requirements, pressure conditions against which the hypochlorite is to be applied, dependability, and durability, and numerous other factors. Moreover, feeders must be evaluated on the basis of the characteristics of the hypochlorite to be employed, particularly its stability and corrosive characteristics. In general, the feeder that will effectively do the required job and will require the least amount of maintenance is the one which should be selected.

Dry Feeders

Dry feeders for applying hypochlorites are used less frequently than solution feeders for most purposes. The slightly hygroscopic and corrosive characteristics which high test calcium hyochlorites develop upon exposure to atmospheric moisture limit their adaptability to dry feed. During the past several years, dry chemical feeders have been improved, and many are accurate and reliable. There are now available several dry chemical feeders recommended for hypochlorite service; some are designed to feed as little as 3 ounces of the dry chemical per 24 hours. Dry feeders, however, appear to be more generally acceptable only where hypochlorite requirements are substantial.

Since the advent of tablet forms of high test calcium hypochlorite there has been developed a simplified special kind of "dry" feeder which involves gradual dissolution of the dry chemical and its introduction in solution form into the medium to be treated. The simplest of these consists of actual submersion of a corrosion-resistant basket, perforated polyethylene bag or similar container filled with hypochlorite tablets, usually near the water inlet of a pool, tank, reservoir, or in a pipeline, where maximum mixing can occur.

A more refined type of dissolving device involves the passage of pressure-controlled water through a cylinder containing the hypochlorite tablets, and the introduction, by gravity and the pressure of air contained in the unit, of the resultant hypochlorite solution into the medium to be treated. In one type of feeder, small jets of feedwater, controlled by a rotameter type flowmeter, are injected into the lower portion of a distributor tube containing a bed of hypochlorite tablets. The feedwater slowly dissolves the tablets and provides a continuous discharge of hypochlorite solution. The solution discharge rate presumably can be controlled within certain limits by adjusting the feedwater metering valve. The unit is calibrated to cover feed rates between 0.1 and 2.5 lb/hr of available chlorine against a pressure not exceeding 2-3 psi. Higher rates, up to about 10 lb/hr, can be obtained depending on the temperature and pressure of the feedwater. To obtain the maximum feed rate within the calibrated range requires a feedwater pressure at least 8 psi greater than the pressure at the point of application. The unit reportedly is applicable to continuous or semi-continuous systems involving free discharge, discharge into pump suction, or discharge directly into a pipeline, provided that the pressure at the point of discharge is, or can be reduced to less than 3 psi under flow conditions.

The use of dissolving devices eliminates the necessity of preparing and checking stock, hypochlorite-dosing solutions. It would appear that such equipment is particularly well suited to those situations where exacting dosage requirements are not critical, where the greater expense of more elaborate and versatile feeders can not be justified, and where minimum maintenance and upkeep are important. Such applications might include certain low volume industrial potable, processing wastewater systems, private and semi-private swimming pools, condensor and other cooling water systems etc. Where more exacting control is necessary and chemical requirements are substantial, solution feeders can be more satisfactorily and economically employed.

Solution Feeders

For most purposes, solution feeders are preferable to dry feeders for the reasons already discussed. Moreover, fresh stock hypochlorite solutions, can be easily prepared to conform with chemical requirements, and can be more accurately measured and dispensed than the dry material. Many varieties of feeders are available commercially and cover a wide range of operating conditions and economy. They may be designed for continuous, emergency or specialized chlorinating purposes; they may be either manually controlled, operated automatically at a fixed dosage, or operated to provide hypochlorite solution in proportion to the flow of the medium to be chlorinated; and, they may be operated by electric power, belt drive, rotating shaft, water power, compressed air or by power from a gasoline engine.

For the purposes of this discussion, most commercial solution feeders can be classified either as: (1) positive displacement pump feeders, (2) orifice or venturi feeders, or (3) miscellaneous suction gravity feeders. Only a few representative feeders are mentioned here for illustrative purposes.

Positive Displacement Pump Feeders

Positive displacement pump feeders are perhaps the most accurate and also the most complex type of feeder. Their operation depends on a moveable diaphragm, plunger, gear or rotor which proportions the chemical feed rate, the amount being manually or automatically varied by changing the displacement of the diaphragm or the plunger, or by modifying the speed at which the feeder is operated. Many are available with multiple heads to increase the total pumping capacity or to permit simultaneous, independent measurement and discharge of different chemicals. The pumps may be motivated by electric, water or gasoline power, depending on the requirements of each installation.

Many of them are designed for, or can be readily adapted to, automatic proportional flow control. Two positive displacement, pump type feeders are in general use: diaphragm and plunger. Most utilize poppet valves to control intake and discharge, and most are capable of dis-

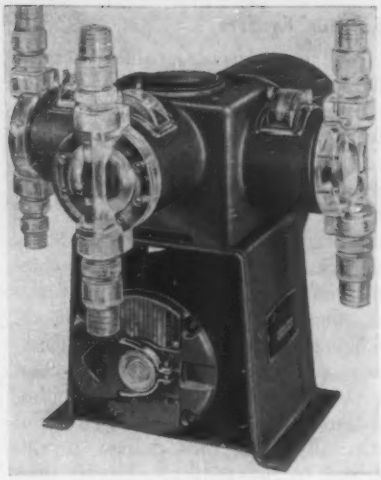


Fig. 1. B-I-F Model 1210 Triplex Chem-O-Feeder Chemical Pump.

charging hypochlorite solution against pressure up to about 100-125 psi. Where discharge is against low or negative heads, the use of an anti-suction device is indicated.

Positive displacement pump feeders appear to be especially applicable where it is necessary to discharge the solution against pressure, where automatic flow proportional feed is indicated, and for continuous treatment systems involving substantial volumes.

Diaphragm Feeders

B-I-F Industries, Providence, R. I., markets a series of electrically-operated diaphragm Chem-O-Feeders, available with simplex, duplex, or triplex pump heads, and suitable for discharge pressures up to 125 psi. Design capacities are rated at 8, 16 and 24 gph, respectively. These solution feeders, illustrated in Fig. 1, are equipped with a three-stop cone drive pulley which permits an overall adjustment range of about 25:1.

The Fischer & Porter Co., Warminster, Pa., electrically-operated diaphragm feeder, available with simplex or duplex pump heads, is designed to deliver up to 65 gal/24 hr, per head, against pressures up to 125 psi. These feeders operate on the principle that a stroke of the pump piston displaces hydraulic fluid which, in turn, creates a pressure on a diaphragm which separates the hypochlorite from the hydraulic fluid. The reciprocating motion of the piston, moved by an eccentric cam, transmits a pulse against the diaphragm which alternately draws hypochlorite solution into the pump and discharges it into the main liquid line. The stroke rate is manually adjustable and controls the feed rate.

Infilco, Inc. Tuscon, Ariz., electrically-operated diaphragm feeder, available with simplex or duplex pump heads (See Fig 2) is designed to deliver up to 2.5, 5 or 10 gal/hr at maximum feed rate, (per head), against discharge heads from —5 to 45 psi. Any feed rate from 1 to 100 per cent of capacity can be obtained,

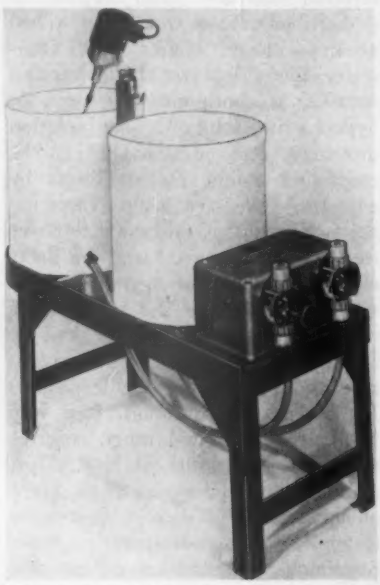


Fig. 2. INFILCO Neusol Duplex Feeder.

reputedly with a consistency of ±2 per cent.

The Precision Chemical Pump Corp., Waltham, Mass., markets two, electrically-operated diaphragm feeders that are especially suitable for hypochlorite applications. Model 801 equipment has an output adjustable between 0 and 20 gal/24hr against pressures up to 60 psi. Model S, heavy-duty feeders, illustrated in Fig 3, are designed to pump solutions at rates from 3 to 60 gal /24 hr, per head, against pressures up to 125 psi; models having up to six independently adjustable multiple heads are also available. In these units a shaded pole electric motor and a reduction gear train reciprocate a diaphragm by means of an eccentric cam. Adjustable over full capacity range, the units reportedly are accurate to within 1 per cent under given pumping conditions.

Wallace & Tiernan, Inc., Newark, N. J., markets a variety of nylon-reinforced rubber diaphragm feeders. The belt-driven A-747-P hypochlorinator operates at capacities of 80, 100 or 250 gal/24hr against pressures up to 100 psi. The stroke length, adjustable over a 10:1 range, can be varied to adjust the feed rate. The "Chlorinet" series, illustrated in Fig. 4, are designed for lighter service and have a capacity of either 1.2 to 6 gal/24hr or 4.8 to 24 gal/24 hr at 100 psi. The pump gear train is driven by a shaded pole induction motor.

In addition to these electrically-powered feeders the company markets a water-powered, "balanced diaphragm" unit (Fig. 5) designed to feed from 0 to 60 gal/24 hr at pressures up to 125 psi in proportion to water flow through a meter. An extension from the meter shaft, which rotates in proportion to flow, pilots the diaphragm pump, and water pressure is used to pump solution in proportion to shaft rotation. Manual dosage adjustments are obtained by varying the length of the pump stroke. Similar feeders are manufactured by H. E. Anderson Co., Muskogee, Ill., and B-I-F Industries, water or air.

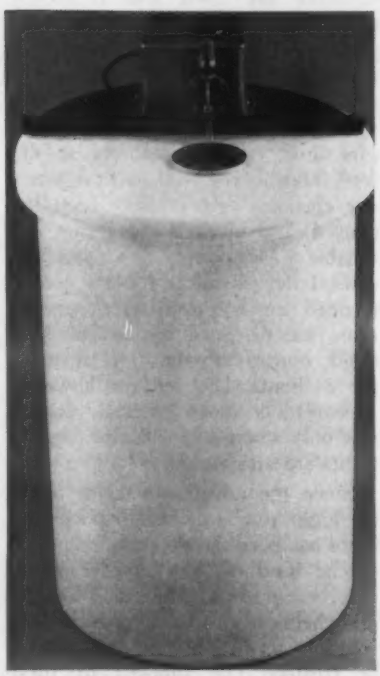


Fig. 3. PRECISION Model S, Heavy Duty Chemical Solution Feed Pump mounted on a polyethylene hypochlorite solution tank.

Fig. 4. WALLACE & TIERNAN Chlorinet Series A-745 Hypochlorinator.

Plunger Feeders

While positive displacement feeders of the diaphragm type appear to be preferred, satisfactory service for hypochlorites also has been obtained using plunger-type solution feeders. For example, the Manzel Co., Buffalo, N. Y., markets a variety of positive displacement solution feeders suitable for handling hypochlorites; primarily these are of the reciprocating plunger type, available in several capacities ranging from 2.6 to 60 gal/hr against pressures up to 5000 psi for some equipment (See Fig. 6). A diaphragm type pump, designed to deliver 1.5 to 15 gal/hr at pressures up to 125 psi, also is available. Drives can be ratchet or direct lever: reduced or direct rotary, belt, chain or motor driven by gas, air or electric motors. A wide variety of muti-feed equipment also is available from this source.

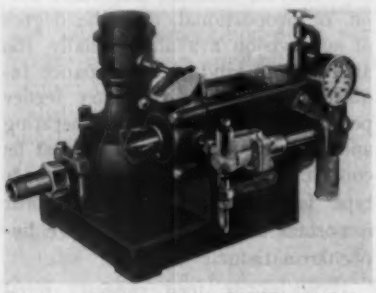


Fig. 5. WALLACE & TIERNAN Water-operated, Proportional Flow Hypochlorinator, Series A-429.

The Milton Roy Co., Philadelphia, Pa., also markets a portable, Model H20 plunger type feeder recommended especially for non-continuous service such as disinfecting new and repaired water mains. This electrically-operated feeder has a maximum metering capacity of 21.5 gph which can be maintained against pressures of 100 psi or more. The company also manufactures a variety of other simplex or duplex "controlled volume", positive displacement feeders covering a variety of operating conditions.

Pressure Differential Feeders

The flow of chemical solution through this type of feeder depends on the development of a pressure differential by means of an orifice, venturi or other constriction. Dosage can be adjusted by either varying the head on a fixed, constant, orifice, by adjusting the hypochlorite solution strength, or by adjusting the orifice size. The most popular of these feeders involve the variable orifice principle of operation. Briefly, a tube from the hypochlorite container is connected to a venturi or orifice in a plastic housing; water from the pressure side of the pump passes also into the plastic housing where it mixes with the hypochlorite, and the mixture is carried to the pump suction where a vacuum exists. This type of feeder is hydraulically operated, simpler than positive displacement pump feeders and, accordingly, less expensive.

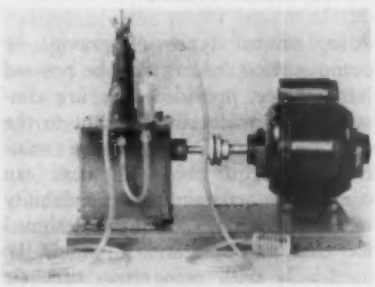


Fig. 6. MANZEL Plunger-type Chemical Pump Feeder.

Fischer & Porter Co., Hatboro, Pa., markets several models of "Super—H Chemical Feeder" ranging in capacity from 2 to 25 gal/24 hr to a maximum of from 50 to 500 gal/24hr against pressures up to 100 psi. One of these feeders is illustrated in Fig. 7. Operation depends on the ejector principle: water enters the chemical feeder, flows through an ejector and creates a partial vacuum which induces the reagent to flow through a metering tube, a rate valve, a differential pressure regulator, and into the main stream flow at the ejector. The flow rate is metered with a rotameter, manually adjusted by a needle valve on front of the unit, and automatically regulated by the differential pressure regulator which maintains a constant pressure across the rate valve. These feeders are equipped with a spring-loaded, backflow check valve.

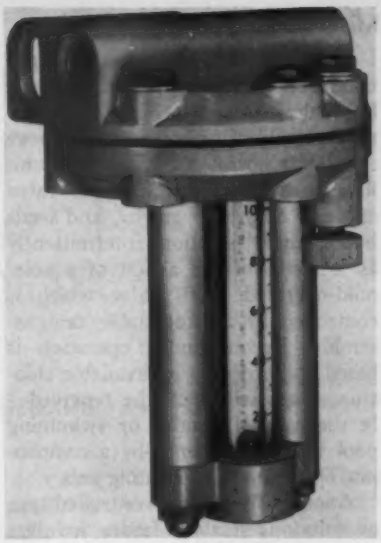


Fig. 7. FISCHER & PORTER Model 70M2021 Super-H Chemical Feeder.

Units operating on the same basic principle, but varying in construction details, are also manufactured by Paddock of Dallas, Tex., having a capacity of about 6½ to 100 gal/24 hr; the Chloromerger Company, Inc., Athens, N. Y., and others.

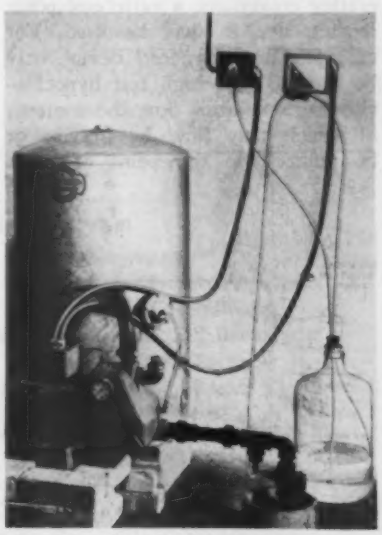


Fig. 8. EVERPURE Everchlor Automatic Interrupted-feed Hypochlorinator.

Miscellaneous Suction Feeders

Everpure, Inc., Chicago, Ill., manufactures an "interrupted feed" type hypochlorinator which utilizes suction, gravity or siphon action to move the hypochlorite solution. The unit illustrated in Fig 8, has a rated capacity of 0 to 5 gal/hr, and feeds hypochlorite solution intermittently as a result of the action of a solenoid-operated pinch valve which is controlled by an adjustable cam assembly. Recommended operation is based on providing an available chlorine excess which can be removed—in the case of potable or swimming pool water treatment—by a companion, optional, dechlorinating unit.

Another simpler air-controlled type of solution, suction, feeder involves connection of the hypochlorite solution tank with the suction side of a water pump and flow control by an air metering device which lets air into the hypochlorite solution container to replace the solution which is withdrawn. The "Chlor-Matic" suction unit (See Fig 9) marketed by Jamco Laboratories, Canoga Park, Calif., operates by this principle.

The above feeders usually are installed to operate synchronously with a water supply or recirculating pump. Recommended use is generally limited to domestic or low flow industrial installations.

Emergency Equipment

For temporary application of hypochlorites, or under emergency operating conditions, a variety of other feeding devices may be used. For example, any dry feed device may be used to feed high test hypochlorite into a solution box, the contents of which may flow by gravity or be pumped to the point of need.

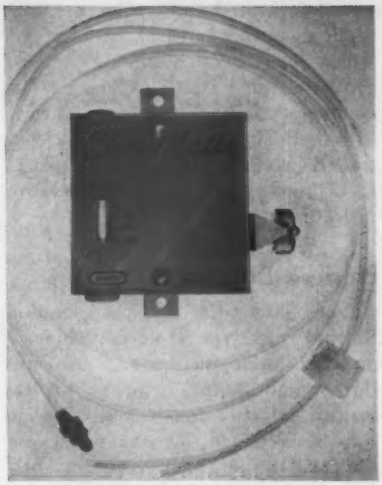


Fig. 9. JAMCO Chlor-Matic Air-controlled Suction feeder.

Also, several types of gravity or pump suction feeders may be pressed into service, provided they are constructed of materials resistant to the corrosiveness of hypochlorite solutions. None of this equipment can compare in accuracy or dependability to liquid feeders specifically designed for this purpose, and it should be used only with recognition of their inherent limitations. Such equipment should be considered makeshift and for only temporary use; under no circumstances should it be provided for standby service such as in the event of gas chlorinator failure.

Feeder Operation

Satisfactory operation of an hypochlorination facility and, consequently, the efficacy of chlorine treatment, can not be assured unless sufficient care is given to the selection, installation, operation and maintenance of the hypochlorite feeder. Principal among the factors to be considered are the type and capacity of equipment, and adherence to minimum maintenance requirements.

Feeder Selection

There is a sufficiently wide variety of hypochlorinators or other chemical feeders currently on the market to cover almost any conceivable situation. The chief considerations involved in selecting a feeder is job requirement; treatment objectives, purpose; scope of treatment, continuous or intermittent; flow to be treated, quantity, quality, and fluctuations thereof; and chemical requirements, amount, kind, and availability thereof. Related to job requirements, adequate consideration also must be given such factors as: available means of actuating feeder, water, air, electric power etc.; point of application, open stream or basin, pump intake or discharge, pressure main, etc. and pressure, positive or negative at the point of discharge; control desired, manual, automatic off-on, or proportional, and, the degree of supervision available. Finally, the amount and kind of maintenance required to insure satisfactory feeder performance, and initial, operating and maintenance costs, also must be considered. Selection of the proper type feeder is the first and most important step towards effective hypochlorination.

Hypochlorite feed capacity must be considered in relation to treatment requirements and strength or potency of the hypochlorite solutions

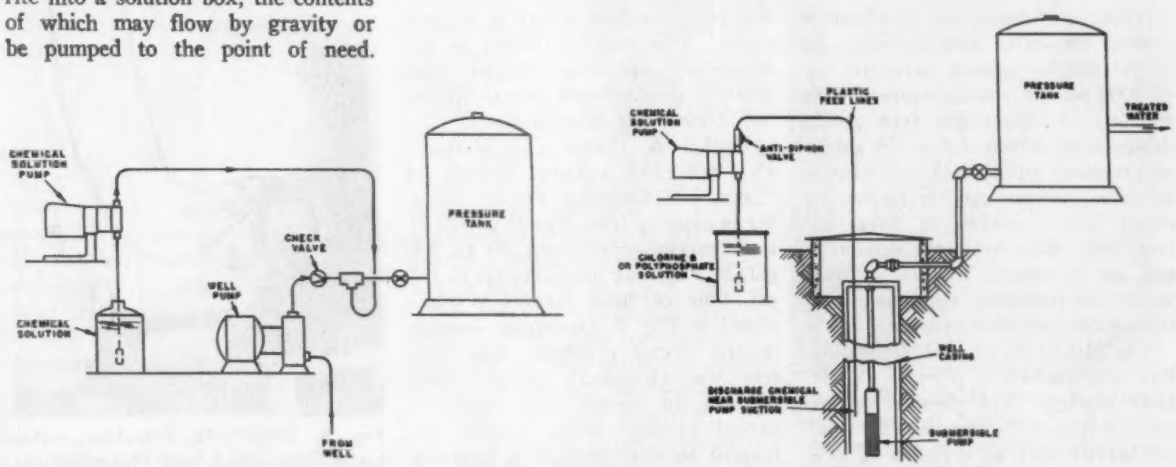


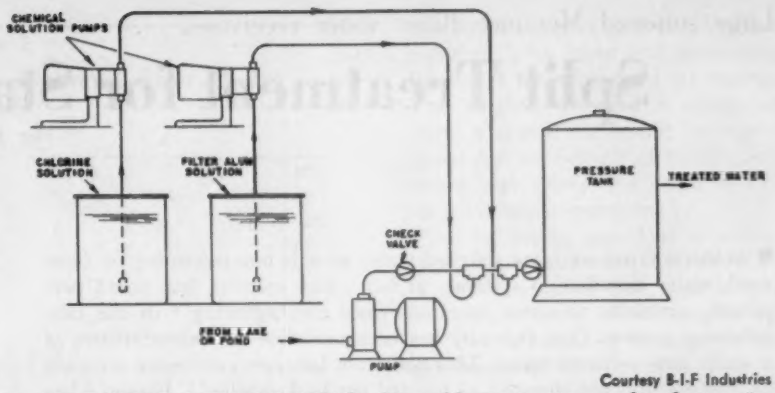
Fig. 10. TYPICAL INSTALLATIONS for Hypochlorite treatment of well water supplies.

applied. In the case of dry feeders, particular precautions must be taken against false weights or volumes resulting from moisture absorption by the hypochlorite, external to or within the feeder itself. In the case of solution feeders, capacity requirements must be based on a solution strength consistent with the design of the feeder. If, for example, industrial strength hypochlorite solutions are not recommended for use with any particular equipment and sufficient chemical can not otherwise be fed under hydraulic conditions prevailing, a feeder of greater capacity may be required; similarly, if chemical requirements are so low as to necessitate use of less than 1 per cent hypochlorite solution at minimum feeder discharge rate, equipment of lesser capacity is preferable. In addition, product stability and degradation must not be overlooked.

Having selected the proper type and capacity of feeder consistent with job requirements and related considerations discussed above, it must be installed and operated in accord with sound engineering principles and professional judgment, and with full recognition of its particular weaknesses or limitations. A number of typical solution-feeder installations are illustrated in Figs. 10 and 11.

Feeder Maintenance

No hypochlorinator is so automatic or mechanically refined as to require no maintenance. Even the best of chemical feeders must be regularly cleaned and serviced to insure efficient, continuous operation. Furthermore, unless an alarm system is incorporated to provide warning of interruption of feeding, the hypochlorite supply must be periodically checked and replenished as necessary.



Courtesy B-I-F Industries

Fig 11. TYPICAL INSTALLATION for Hypochlorite treatment of surface water supplies.

Probably the major source of difficulty associated with most feeders is the clogging of needle control valves, small orifices and venturi throats, ball check valves, inlet and outlet poppet valves and similar constrictions. Clogging appears to be particularly prominent where water contains significant concentration of hardness, iron, mineral and other particulates, and as a result of calcium in suspension in high-test hypochlorite solutions. Often, such deposits are difficult to control or eliminate completely, and accumulations should be removed by brush-cleaning affected parts, using 5 per cent muriatic or acetic acid solutions, as necessary. Daily flushing of all vital feeder components with clear water is a good preventive practice.

Much of the clogging due to calcium deposits can be reduced if proper care is exercised in preparing the hypochlorite solution; i.e., premixing, settling and decanting or siphoning off the clear liquid. There should be a strainer on the feeder solution intake which should be brush-cleaned and flushed daily or as otherwise necessary. In extreme cases, the use of sequestering agents such as sodium hexametaphosphate may be indicated.

Hypochlorinators should be taken apart and inspected at least semi-annually, and worn or damaged parts should be replaced. It is good practice to maintain a supply of replacement parts such as poppet valves, valve seats, diaphragms, O-rings, feeder tubes etc. for ready availability. This is especially important when no stand-by equipment is provided and when continuity of hypochlorite treatment is essential. Strict adherence should be paid to lubrication instructions issued by the manufacturer.

References

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Flynn, Robert A., "Hypochlorination: Set It Up, and Keep It Up." *Water Conditioning Sales*, (July 1960).

AWWA 81st Annual Conference (CONTINUED FROM PAGE 144)

SESSION 14 — THURSDAY PM

Diffusion of Radioactive Materials in Surface Streams — R. C. GODFREY
Controlled Induced Recharge — MORRIS DEUTSCH
Water Use in the U.S. — KENNETH A. MACKICHAN
Operating Experiences Under New Water Laws — GEORGE E. FERGUSON

SESSION 15 — THURSDAY PM

Peak Demands in Residential Areas — JEROME B. WOLFF
Putting Peak-Demand Data to Work in Operation and Design — HOLLY A. CORNELL
Demand Rates for Water Service — W. L. PATTERSON

Detroit Social Program

DAY	TIME	EVENT	PLACE
Sun.	1 PM	Exhibit Open House	Cobo Hall Exhibit Area
Sun.	8:00 PM	Meet & Greet Night	Cobo Hall Ballroom
Mon.	11:30 PM	Fashion Show & Luncheon	Rooster Tail Restaurant
Mon.	8:30 PM	Awards & Reception	Cobo Hall Ballroom
Tues.	8:00 AM	Golf Tournament	Hillcrest Country Club, Mt. Clemens
Tues.	——	Sugar & Spice Breakfast & Tour	——
Tues.	7:30 PM	Carnival Night	Cobo Hall Convention Arena
Wed.	7:30 AM	Fuller Award Breakfast	——
Wed.	10:30 AM	Outdoor Barbecue & Tour	Greenfield Village
Wed.	12 NOON	Manufacturers Luncheon	——
Thurs.	2:00 PM	Ladies Boat Trip	Leave foot of Woodward Ave.
Thurs.	6:30 PM	Annual Banque & Ball	Cobo Hall Ballroom

Lime softened Meramec River water receives . . .

Split Treatment for Stabilization

by J. L. TUEPKER,
Supt. of Purification,
St. Louis County Water Co.
University City, Missouri

■ STABILIZATION OF LIME softened water so it is non-incrusting on filter sand, water distribution systems, or hot water systems, has posed perplexing problems to water operators since the beginning [1] of the lime softening process. One difficulty has been to define the characteristics of a stable lime softened water. This definition becomes even more complex as temperatures are elevated, as pointed out by Langelier [1]. Larson [2] has given his definition of an ideal lime softened water and more recently [3] proposed a magnesium index for predicting the tolerable amount of residual magnesium in lime softened water.

In the stabilization of lime softened water, the water plant operator must think about the corrosive properties of water as well as about the possibilities of scale deposition. Uhlig [4] has stated: Water treatment for very large systems, by reason of cost involved, is usually limited to pH control and intentional deposition of calcium carbonate scale. As corrosion prevention is ultimately an economic problem, it is always important to consider cost in selecting a system of treatment for any specific purpose. Metal parts of hot water systems generally last less than one-third as long as those of cold water systems unless the dissolved oxygen has been reduced, or other protection provided. The maximum temperature of hot water supply systems should be limited to 140°F, unless the water is well treated or de-aerated. The water treatment plant operation objective at the St. Louis County Water Company is: To produce a water which has a total hardness of 100 ppm (as calcium carbonate), or less, which will be non-corrosive and will not cause incrustation to the filter sand, to the distribution system, or to domestic hot water systems when the hot water heaters are operated at 140°F or less and the detention time in the heater is no longer than 24 hours.

Laboratory studies were undertaken to:

1. Determine the chemical characteristics of a water which will meet the requirements of the above conditions,
2. Determine the processing required by Meramec River Water to produce such chemical characteristics, and
3. Determine plant flow sheet arrangement and plant design which will produce such a water economically.

Desired Chemical Characteristics

To determine desired chemical characteristics of a lime softened water which would be stable at 140°F, the characteristics of the plant's hot water heater's influent and effluent water have been measured daily for two years.

A review of these data have shown:

1. Influent water containing 60 ppm magnesium and having a pH of 9.8 will precipitate both calcium and magnesium,
2. If the pH of the water was lowered to 9.2 no precipitation occurred,
3. If the residual calcium and magnesium were 40 ppm, or less, no precipitation occurred in the heater when the influent water had a pH of 9.8.

These data give indications of the desired chemical characteristics of a lime softened water. However, to determine the upper limit of residual calcium and residual magnesium in a lime softened water, which will not precipitate in 140°F hot water heaters, the following experimentation was undertaken:

Meramec River water was softened by conventional jar testing to various calcium and magnesium residuals, the pH adjusted to various levels by adding coagulant and chlorine. The water was filtered to remove suspended particles. Pyrex bottles containing these treated waters were immersed in a constant temperature hot water bath and held at 140°F for 24 hours. The water from the bottles was then filtered through a type HA membrane filter to remove any fine precipitate. Residual calcium and magnesium was determined. The chemical characteristics of waters investigated which did not precipitate calcium or magnesium under these conditions are listed in Table 1.

Chemical Treatment Required

Studies to determine the processing required by Meramec River water to produce a lime softened water with the characteristics listed in Table 1, were based on high solids contact softening methods.

Meramec River water has widely varying characteristics since it is subject to flooding from local run off. This study was confined to waters

Table 1

Analysis Of Water Before And After Heating To 140°F and Holding For 24 Hours

Water Characteristics @ 25°C				Residual Ca and Mg After 24 Hours	
	PPM as $CaCO_3$			PPM as $CaCO_3$	
pH	P-M ALK	Ca	Mg	Ca	Mg
9.0	11/141	58	72	58	72
9.2	12/88	48	58	48	58
9.4	13/48	48	56	48	56
9.6	15/66	46	46	46	46
9.8	17/59	44	42	40	42
10.0	18/56	40	42	40	42

Table 2

Chemical Characteristics—Meramec River Water

	ppm Except pH
Turbidity	25
Dissolved Solids	240
pH	8.2
Alkalinity	165
Total Hardness	190
Calcium Hardness	90
Magnesium Hardness	100
Iron	0.0
Sodium & Potassium	6
Nitrates	1.5
Chloride	10
Sulfates	20
Silica	8

having characteristics which present problems in softening and stabilization. A typical analysis of such water is given in Table 2.

In a previous article[5], the advantages of utilizing previously precipitated retained slurry for more complete lime softening reactions was shown. It was also shown that water approaching the desired characteristics could be produced by recirculating approximately 4 per cent by weight of slurry.

Continuing studies have shown that with this treatment water having calcium and magnesium residuals of approximately 40 ppm could be produced. The water would contain approximately 10 ppm hydroxide alkalinity, 2 P-M, and have a pH of approximately 10.1. It is desirable to use this hydroxide alkalinity in the softening process if possible.

Softening curves were made on the Meramec River water to determine the amount of lime required to give the desired hardnesses listed in Table 1. The results of these studies are shown in Figure 1. Figure 1a shows what the resultant hardness would be if no retained slurry were used, and Figure 1b shows the resultant hardness when 3.8 per cent retained slurry was used. The advantages of the retained slurry are obvious. All subsequent studies were made using retained slurry[5].

It was reported previously[5] that slurry contained turbidity, coagulant, activated silica or magnesium hydroxide may not be as efficient in promoting softening reactions as a pure calcium carbonate slurry. Figure 2 slurries were all prepared from Meramec River water by feeding a specified amount of lime to a 5 gallon a minute pilot plant and generating the slurry for subsequent jar testing. This method provided a means of using a slurry that could be reproduced for verification of results and also a type slurry that could be expected in plant operation.

All jar testing was done in a constant temperature water bath at 50°F. It was determined that a lime feed of approximately ½ milliequivalent per liter in excess of the bicarbonate alkalinity plus the magnesium equivalent was required to reduce the calcium and magnesium to the desired level. 3.8 per cent retained slurry and a 20 minute mixing time was used in

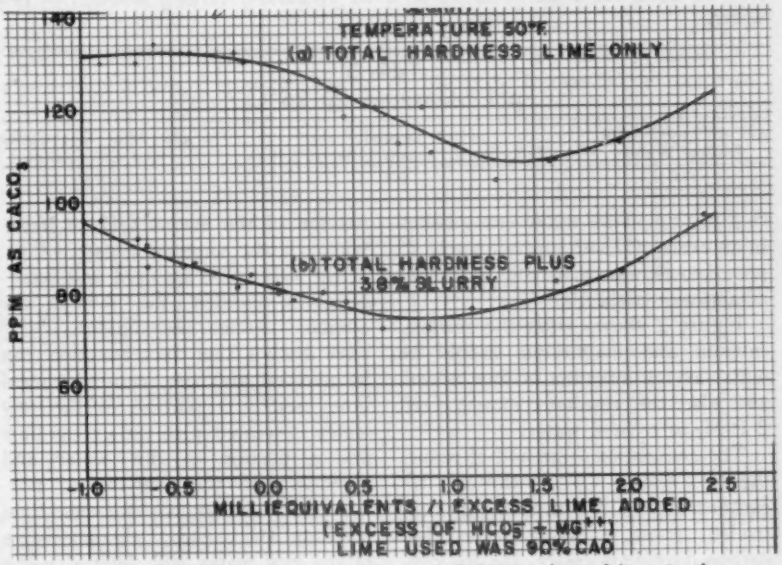

Fig. 1. LIME SOFTENING Meramec River with lime only and lime in the presence of 3.8 per cent recirculated slurry.

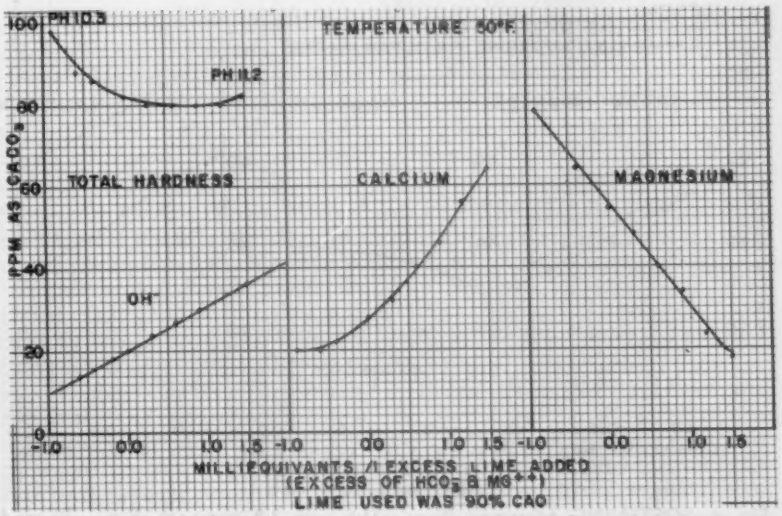

FIG. 2. LIME SOFTENING Meramec River water in presence of 3.8 per cent recirculated slurry.

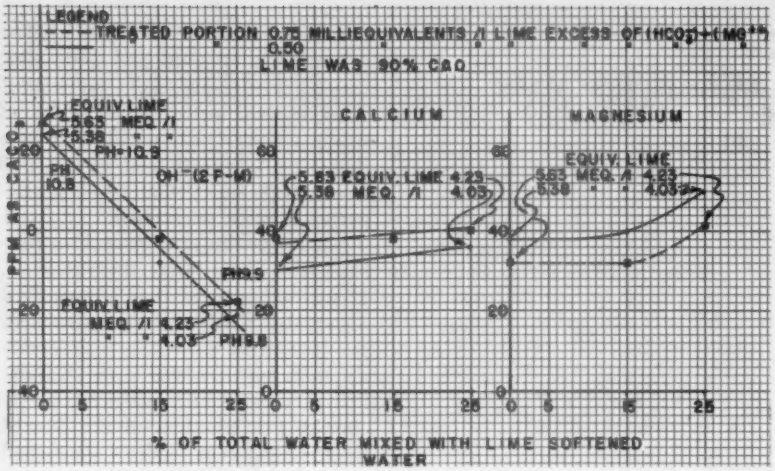

Fig. 3. HYDROXYL ION distribution and residual calcium and magnesium of lime softened Meramec River water when by-passing varying amounts of raw water.

Table 3
pH Measured @ 25°C

pH of Excess Lime Treated Water	pH of Blended Water 75% Treated Excess Lime, 25% Raw	pH After Coagulation and Chlorination
11.0	9.9	9.5

this testing. This treatment resulted in an excess OH of approximately 25 ppm as calcium carbonate and a pH of approximately 10.7.

Figure 2 shows what the residual calcium and magnesium would be with varying amounts of lime added, and also the resultant excess OH, 2 P-M, in treated water.

The conventional method of reducing this excess OH is through recarbonation. This method, if controlled, gives a stable water, but carbon dioxide is costly, and the conversion of the excess OH to bicarbonate is the same as a loss in lime. If the OH could be used and recarbonation avoided, the savings are obvious. Some investigators [6, 7, 8] have shown that recarbonation can be avoided and the required excess lime used if a portion of the raw water is treated with the excess lime and a portion of raw water and blended with the over-treated portion later. The amount of excess lime used and the chemical characteristics of the raw water will determine the per cent raw water that should be bypassed.

Sufficient raw water must be bypassed to furnish bicarbonate alkalinity to react with the excess OH. When this is done, it can be expected some hardness will be added because the overall effect is that of a reduction in lime feed. However, if properly controlled, the excess OH should precipitate most of the calcium in the bypass portion and the only hardness addition would be that of magnesium.

To determine the possible use of excess hydroxide alkalinity by bypassing a portion of the raw water and its effect on residual calcium and magnesium, raw water was treated with specified excess lime and blended with varying amounts of raw water.

The decrease in hydroxide alkalinity and residuals of calcium and magnesium are shown in Figure 3.

It is important to note the very small increase in total hardness, while the equivalent lime dose was reduced 1.4 milliequivalents per liter by bypassing 25 per cent of the raw water. The increase in residual OH is noted when an excess of 0.75 milliequivalents per liter of lime was less than the decrease in residual magnesium when compared to an excess lime feed of 0.5 milliequivalent per liter. This indicates that, by adding an excess of approximately 0.75 milliequivalent per liter lime to 75 to 80 per cent Meramec River water in the presence of 3.8 per cent recirculated slurry, and bypassing 20 to 25 per cent raw water, a lime softened water of desirable calcium and magnesium residuals can be produced at pH of approximately 9.9.

Plant operating experiences have shown coagulation and chlorination will further reduce the pH by 0.2 to 0.5 units. This being true, it is expected water treated as described will have a final pH of 9.4 to 9.7.

To verify this, more jar tests were run. Softening was in the presence of slurry with 0.75 milliequivalents per liter of excess lime. The treated water then blended with 25 per cent raw water, adding normal plant coagulant doses and normal plant chlorine doses; the resulting pH's are shown in Table 3.

The results of this study have not indicated that increased hardness reduction can be obtained by using a split treatment process, but rather

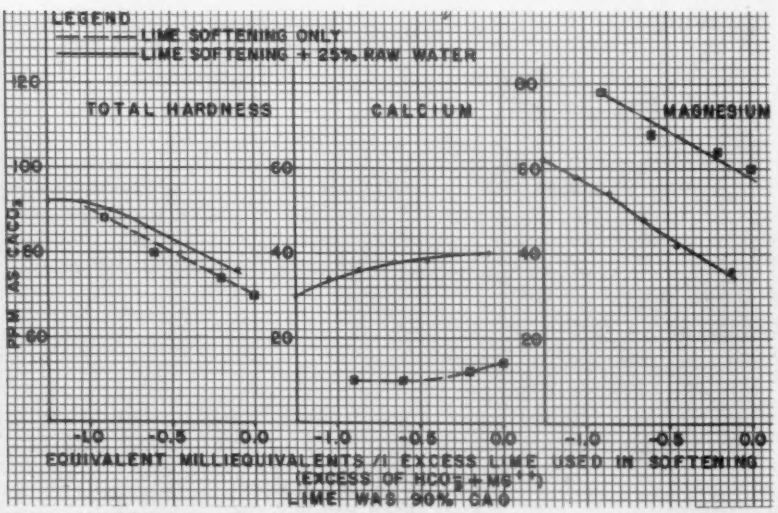

Fig. 4. SOFTENING Meramec River water with 3.8 per cent slurry with and without split treatment.

that the water can be made more stable by removing a greater per cent of magnesium and a lesser per cent of calcium. Figure 4 shows the resultant distribution of calcium and magnesium when lime softening only, in the presence of 3.8 per cent slurry, is compared to lime softening with an excess of lime and 25 per cent raw water bypassed. The same equivalent lime feeds apply.

It is important to note when lime equivalent to the bicarbonate alkalinity plus one-half the magnesium is fed in the presence of 3.8 per cent slurry, the residual calcium is held to 10 ppm, but the magnesium is reduced to only 70 ppm, approximately 30 per cent reduction. The pH of this treated water was 10.4 and the OH was approximately 16 ppm. If this same amount of lime was fed to 75 per cent of the raw water, this 75 per cent would receive a lime dose equivalent to an excess of 0.5 milliequivalents per liter of lime, and the magnesium would be reduced to approximately 40 ppm, while the calcium increased to 40 ppm, Figure 2. If this water is then blended with 25 per cent raw water, actual lime equal to bicarbonate alkalinity plus one-half magnesium, as before, the total hardness increases only 4 ppm. The calcium remains at 40 ppm and the magnesium increases to 44 ppm. The pH of this blended water was 9.8 instead of 10.4 as when the same amount of lime was added to all of the water. The pH will be further reduced to approximately 9.5 by coagulation and chlorination. Water of these characteristics

pH 9.5
Alkalinity, approximately 50 ppm
Calcium, approximately ..40 ppm
Magnesium, approximately 45 ppm

should be non-corrosive and non-incrusting at temperatures to 140°F.

Requirements in The Design of a Plant

At the beginning of this study, the desirability of using recirculated slurry was established. Operation of the 5 gallon a minute pilot plant gave a slurry from which handling procedures could be established.

Intimate contact of the water with the slurry is required and this is best accomplished by rapid agitation or through pumping. The desired contacting time was found to be approximately 20 minutes.

To produce a stable lime softened water from Meramec River water, considerable magnesium hydroxide is precipitated. This magnesium hydroxide is light and only a small per cent is retained in the recirculated slurry. The recirculated slurry remains approximately 75 per cent calcium carbonate. The magnesium hydroxide is carried out of the contacting unit and must be settled out of the water before the pH is reduced, or magnesium will go back into solution defeating the purpose of the split treatment.

To utilize the recirculated slurry in split treatment processing and water softening in a 20 mgd addition of the St. Louis County Water Company's South County Plant treating Meramec River water, an upflow solids contacting basin was selected as a softening unit. Figure 5 shows a block diagram of this 20 mgd addition.

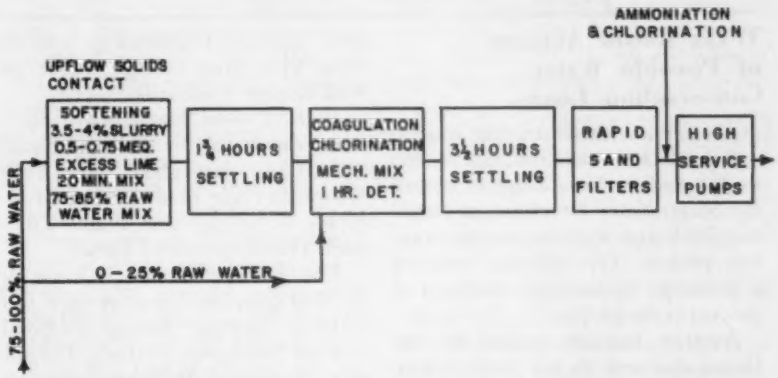
AMMONIATION & CHLORINATION
UPFLOW SOLIDS CONTACT
SOFTENING 3.5-4% SLURRY 0.5-0.75 MEQ. EXCESS LIME 20 MIN. MIX 75-85% RAW WATER MIX
1¾ HOURS SETTLING
COAGULATION CHLORINATION MECH. MIX 1 HR. DET.
3½ HOURS SETTLING
RAPID SAND FILTERS
HIGH SERVICE PUMPS
75-100% RAW WATER
0-25% RAW WATER

Fig. 5. FLOW DIAGRAM of the St. Louis County Water Company's South Plant 20 mgd addition.

It is expected that the water in the softening basin will receive between 15 and 20 minutes intimate contact with the recirculated slurry. Lime will be fed into the slurry and even though provisions have been made for solids liquid separation, it is expected the turbidity of the effluent of this solids contact unit will be 75 to 100 ppm. This turbidity will be principally magnesium hydroxide. The slurry concentration in the contact unit will be controlled by blow-down if it builds to an excess of approximately 4 per cent by weight. The amount of blow-down required will depend upon the amount of precipitation products and the carry-over from the unit.

The settling basin following the softening unit has a detention time of 1¾ hours. The magnesium hydroxide should settle in this basin so the turbidity of the water entering the mixing-coagulation zone will be less than 15 ppm.

It is proposed to introduce the coagulant and the chlorine with the bypass portion of the raw water and distribute them uniformly across the mixing-coagulation zone. One hour mechanical mixing is provided in this zone.

Three and one-half hours settling are provided for the coagulated water ahead of the filters. This will result in a water of less than 2 ppm turbidity on the top of the filters.

The incoming raw water and the bypass portion of the raw water are metered. The station operator will have positive control at all times of the amount of water bypassed by throttling hydraulically or pneumatically operated valves. The amount of water to be bypassed will be established through laboratory control of the chemical characteristics of the treated water.

A unique feature of this plant is that all units including filters are in a common basin. This type of design was used and reported by Hartung [9] in the initial 15 mgd South County Plant.

Summary

Pilot plant and laboratory jar testing of Meramec River water have shown:

Lime Softened Meramec River water should have a pH of 9.6 to 9.8 with calcium and/or magnesium residuals between 40 and 50 ppm as calcium carbonate if the water is to be non-incrusting of hot water systems operated at 140°F.

Recirculated precipitated slurry is very advantageous in promoting lime softening reactions.

Approximately 0.5 milliequivalents per liter of lime in excess of the bicarbonate alkalinity plus magnesium is required to reduce the residual magnesium to 40 ppm if 3.8 per cent recirculated slurry is used and the mixing contacting time is 20 minutes.

The excess lime may be used by bypassing a portion of the raw water and the total lime requirement will be approximately ½ milliequivalent per liter less than the bicarbonate alkalinity plus magnesium.

In combining solids contacting with split treatment, increased calcium residual and decreased magnesium residual will be obtained in the treated water.

Magnesium hydroxide will be carried out of the recirculated slurry and must be settled out before reducing the pH.

Present water treating equipment can be adapted to the process.

Conclusions

Meramec River water can be lime softened so that it is stable at 140°F by treating approximately 75 per cent of the water with 0.5 milliequivalent per liter excess lime in the presence of 3½ to 4 per cent recirculated slurry, by bypassing approximately 25 per cent of the raw water and taking advantage of normal coagulant and chlorine dosages for additional pH reduction.

This treatment utilizes lime efficiently and enables the water plant operator to produce a quality product with the minimum of capital investment for chemical treating facilities.

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Texas Raises Amount of Possible Water Conservation Loans

The Texas legislature has enacted a bill which raises from $5 million to $15 million the amount of money the State Water Development Board may lend on a single water conservation project. The bill also removed a limitation on loans to one-third of the cost of the project.

Another measure passed by the House and sent to the State Senate was bill HB 54, which would give the State Water Development Board more latitude in investing funds with an objective of stepping up interest yield.

Handbooks for Sewage Treatment and Water Treatment Operators

Health Education Service is currently distributing a pair of handbooks, one for sewage treatment plant operators, the other for water treatment plant operators.

"The Manual of Instruction for Sewage Treatment Plant Operators," has 250 pages. "The Manual of Instruction for Water Treatment Plant Operators," has 164 pages. Both were produced by the New York State Department of Health, assisted by the Colleges of Engineering of Cornell and New York Universities, the Chemistry Department of Niagara University and Rensselaer Polytechnic Institute's Division of Soil Mechanics and Sanitary Engineering, and the New York State Sewage and Industrial Wastes Association.

Both of these Manuals are distributed extensively by the State Health Department throughout New York, where they are used as texts in the Grade II Sewage and Water Treatment Plant Operators Courses.

The Sewage Manual is made up of 15 chapters which cover such subjects as Sewage, Sewage Disposal, Sewage Treatment Methods, Preliminary Treatment, Primary Treatment, Secondary Treatment, Chlorination of Sewage, Sludge Treatment and Disposal, Gas from Sludge Digestion, Industrial Wastes, Sampling and Testing Procedures, Records and Reports, Maintenance of Plant and Equipment, Treatment Plant Safety, Hydraulics and Electricity.

Winnipeg Names Bubbis To Head Waste & Waterworks Division

Mr. N. S. Bubbis, a widely-known Civil Engineer, has been appointed Director of the Waste and Waterworks Division of the Metropolitan Corporation of Greater Winnipeg, effective January 1, 1961. Since 1949, Mr. Bubbis has been General Manager and Chief Engineer of the Greater Winnipeg Water and Sanitary Districts, two inter-municipal Boards which now cease to exist.

Under the Metro Act, the Corporation will become responsible for all previous functions of the two Districts. In addition, it will have much broader authority to carry out projects designed to improve water supply and sewage disposal in the metropolitan area.

Mr. Bubbis will direct all waste and water operations under the jurisdiction of the Corporation. He will set standards for location and construction of facilities connected with the storage, transportation, treatment and disposal of water and waste, working in co-operation with all other Divisions of Metro, particularly the Planning Division.

Landscrapes

CONTINUED FROM PAGE 137

let the ends of the dam go straight, level and secure into the hillside. Let us be magnificently right,—not puny or ashamed with what we have done, trying, by trickery, to suggest that a dam is a piece of countryside that happened to flow that way. Let's make people marvel and come sightseeing to wonder at what we have built, and not have them ask—"Well, if it *is* a dam, why doesn't it look like one?" People are so apt to ask awkward questions.

Keep 'em Rolling

by C. G. Cunningham

■ DO YOUR TRUCKS, diggers, dozers, back hoes and every other water cooled piece of equipment in your water and sewer department get twice-a-year servicing on their cooling systems? They should, and it's time again to think about the Spring treatment. Use this check list as a guide:

- Drain the cooling system. If rust shows, flush out the system completely, using a cleaner if one is needed.
- Even if the coolant is clean, the rust inhibitors probably are used up. Some metals can corrode without coloring the coolant.
- Look for leaks in your hoses and hose connections around the "freeze-out" plugs, gaskets, water pump seals and heater fittings.
- Fill the radiator with soft water and a good rust inhibitor. Inhibitors lengthen the life of a cooling system. Use one.
- Don't save used anti-freeze—even permanent type. "Permanent" means only that it won't boil away. It loses its rust inhibitor's effectiveness after one season's use. Throw it out.
- Refill the system, run the engine and check for water leaks. Be sure the radiator core is free of dirt and insects by blowing it out with an air hose. Check temperature gauge. Check for coolant loss.
- A good cooling system check right now can save you a lot of trouble this summer.
- If you use the new "year-round" type of cooling system fluid such as Dowguard, test it to determine its effectiveness. Dow says in some cases this fluid is good for two years.

Don't make the mistake of thinking you can pull out your truck's thermostat now that the weather is warming up. And don't remove the thermostat to "correct" a cooling system overheating problem. This can greatly increase fuel consumption, reduce power and contribute to spark plug fouling due to the accumulation of excessive carbon deposits on the insulators.

If you run into excess plug fouling, always check to see if that vehicle has a thermostat in it. Your thermostat is important to get the engine up to its most efficient operating temperature quickly and to keep it there through proper coolant circulation.

Could your department save money if you had a dynamometer in your shop? A number of large commercial garages, and some city utilities are finding dynamometers a paying proposition.

A chassis dynamometer gives you all the advantages of road testing a repaired vehicle, yet overcomes the disadvantages of road testing. These will work only on rubber-tired rigs, of course. The speed is measured in miles-per-hour and the performance in horsepower—that amount of actual power delivered at the rear wheels.

With this testing device, you can test the functions of an engine, transmission, drive line, axle, rear wheels and rear tires exactly as they operate on the road.

You can also use a dynamometer before repairs are made. This way you get a clearer picture of what is wrong. Driver complaints and hit or miss diagnosis are often wrong or too general to help you find the real trouble. Pinpoint diagnosis with a dynamometer is economical and practical with the "under-load" method of testing.

After repair, another turn on the dynamometer will tell you immediately if the work you did was done correctly, and if the new parts are "running in" correctly.

For every gallon of gas or diesel fuel you burn through an engine, more than a gallon of water is produced by the engine. It leaves as vapor—if the exhaust is hot, otherwise it drips out.

During the past few years, there has been an increasing demand for a small oil testing meter that could be put in the oil line of a truck and give an indication of the condition of the lube oil.

One such meter now on the market is made by Gerin. They made their first model 15 years ago, and have been refining it since.

Long experience with oil testing convinced Gerin that they needed a single index to show used lube oil condition. For this they picked viscosity. Viscosity of oil changes when it becomes deteriorated or contaminated.

Several such meters are now on the market, but the Gerin has certain new features. It will accurately indicate percentage of viscosity change, up or down, whether the oil is hot or cold.

It works this way: When you change oil, a small compartment inside the meter automatically takes in and holds a sample of the fresh oil. After this the meter compares the crankcase oil with this original sample and shows the result visually on a small scale with pointer. The crankcase oil circulates through the meter and around the sample, keeping it the same temperature as the lube oil. This eliminates the temperature variable when comparing the samples.

Engine oil pressure keeps the meter ready to compare samples automatically. It samples when the engine is stopped, or by manually closing the meter's oil inlet valve when the engine is running. The meter reading stays in position when the engine is turned off. In this way the driver, mechanic or the man checking the oil level at the end of a run can also check the viscosity reading.

For effective preventative maintenance, lube oil condition is one of the best indexes. Lube viscosity will show signs of fuel in the crankcase, build-up of sludges and solids, and give indications of water or anti-freeze leaks.

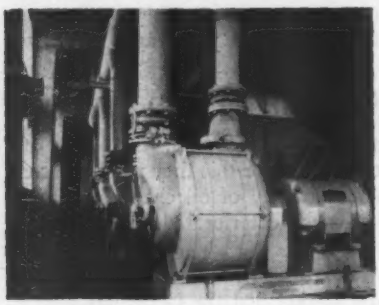
EQUIPMENT IN THE NEWS

For further information on products or services please use reader service card.

Multi-Stage Centrifugal Blower

401

An extensive line of multi-stage centrifugal blowers and exhausters that provide uniform air pressure up to 10 psi, or vacuum up to 12 in. of mercury is offered by the manufacturer. Available in many standard sizes, each unit can use several types of impellers, thus, by varying the number of stages, different ratings and performance characteristics covering a wide performance range can be obtained.

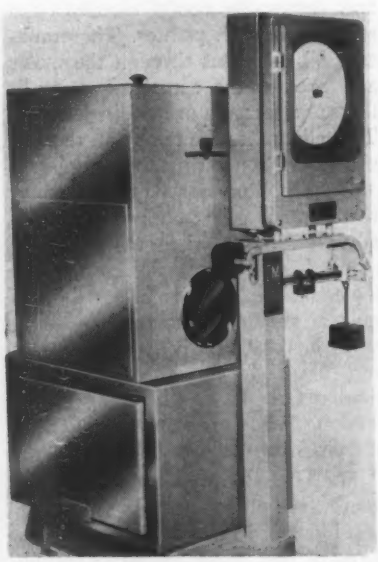


These blowers and exhausters provide clean, dry air or gas at constant pressure for many processes including sewage and industrial waste treatment. U. S. Hoffman Machinery Corp.

Recording Dry Feeder

402

Series A-690 Feeder with Loss-of-weight Recorder controls dry-chemical flow precisely and provides permanent records of feeder operation. Its design assures uniform delivery rates between 0.0045 and 2.8 cu ft per hour.

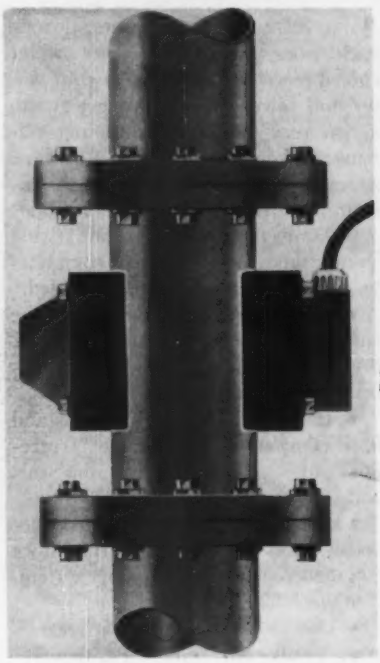


The amount of chemical fed during any desired period is read from 24-hour or 7-day charts. A direct-reading register shows the amount of material remaining in the hopper at any time.—Wallace & Tiernan Inc.

Sludge Reader

403

A new sludge reader that eliminates the problems associated with maintaining proper sludge or slurry flow consistencies passing through pipe lines:

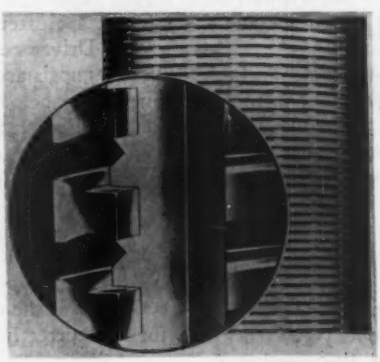


Utilizing harmless nuclear energy, the Sludge Reader will react to changes in solids concentrations passing through the line and, at a predetermined consistency, start or stop the sludge pump.

The Sludge Reader uses a low energy source which passes through the flow pipe and the pipe's contents to a detector mounted diametrically opposite the energy source. Variations in the cludge density in the pipe will cause variations in the nuclear beam as received by the detector. These variations are passed on to a computing circuit that energizes the pump controls. —Komline-Sanderson Engineering Corp.

Well Strainer

404



Exclusive V-shaped self-cleaning slot design permits maximum well delivery over long periods. The strainer's V-shaped slot is larger on the inside than on the outside, preventing sand and gravel entry. Any particle that enters a slot will pass through without choking it.

The V-shaped slot strainer allows for maximum development by removing silt, alluvium, clay and fine sand from around the outside of the strainer.—Cook Well Strainer Co.

Vertical Split Case Centrifugal Pump

405

A new line of vertical single-stage split case centrifugal pumps, recently introduced by the manufacturer, are particularly suitable for applications where extreme compactness is required, handling high capacities at medium to high heads and continuous operation.

The new pumps feature double suction hydraulically and dynamically balanced impellers and streamlined liquid flow channels for smooth, quiet operation; suction and discharge connections on vertical base section for easy inspection and maintenance; and stuffing boxes on both sides of pump centerline and hydraulic pressure seating bronze wearing rings for maximum sealing and minimum leakage. Capacities to 6000 gpm.—The Aurora Pump Div., New York Air Brake Co.

Sludge Valve

406

In expanding its line of manually-operated sludge valves, the manufacturer has recently introduced a fully motorized telescoping model, called the Mo-Tel-Valve. It is factory-assembled, tested and set for the required travel before shipment. Travel can be adjusted in the field if plant operations change. The new units are offered in 5 sizes, from 4 in. to 12 in., utilizing a motorized valve control suitable for single or three phase operation. Standard units provide 4 ft travel.—The American Well Works.

Flow Meters

407

A combination of Indicating Rotor Meter and Pneumatic Transmitter, called the Magnarator, can be used with any metering tube 2½ in. to 2 in. diameter covering flows equivalent to 1 to 100 gpm water and 4 to 400 scfm air.

The flow travels vertically upward through the metering tube, and the float in the tube is magnetically coupled to a rotating follower in the pneumatic transmitter. A dual reading 4 in. vertical output scale indicates the flow rate and the transmitted pneumatic signal which is linear. A horizontal reading scale shows the float position independently of the air supply and transmitter output.—Fischer & Porter Co.

Hose Coupling Repair Machine

408

Electric and hand-operated models of a hydraulic powered hose repair machine will swedge factory-type hose ends for fittings in 30 seconds, reduce machine down time and eliminate procurement problems.

Suitable for the repair or replacement of hydraulic, gas, oil, and water hose using hydraulic power, it is designed so that an operator can repair broken hose or make up new hose in a matter of minutes. Only the small inventory of hose and fittings used in the plant is required for any emergency which may arise. Both electric and hand operated models are available on lease or purchase basis.—Manufacturers Associates.

End Suction Centrifugal Pump

409

A new end suction centrifugal pump features double ball bearings and belt or direct motor drive. Capacity range is from 10 gpm to 300 gpm, and head range to 150 ft. Semi-open impeller is mounted on stainless shaft with precision taper fit for perfect alignment and easy removal. Stuffing box and split gland are standard, but mechanical seal is available at no extra cost. Seal is recommended for temperatures up to 180° when handling non-abrasive fluids.—The Deming Co.

Submersible Pumps

410

Non-clog submersible pumps, newly announced by the manufacturer, are especially designed to handle large solids and stringy materials, such as industrial material or wastes, raw or treated sewage, light sludge and slurries.

These compact, all-in-one pump and motor units are equipped with a one-piece cast iron impeller either in two-blade design or, where excessive clogging would otherwise be encountered, in the bladeless impeller design. Available in 2 in., 3 in., and 4 in. sizes. Typical applications include storm water drainage, small sewage lift stations and general purpose sump drainage.—Fairbanks, Morse & Co.

Propeller and Mixed Flow Pumps

411

Broadening of its line of propeller and mixed flow pumps with the addition of 20 new sizes ranging from 6 in. to 60 in., has recently been announced by the manufacturer. Capacity range of new units is from 1000 to 100,000 gpm at heads up to 50 ft per stage. Speeds are 440 to 3450 rpm.

A number of the new units are being employed in irrigation, flood dewatering, storm sewer, industrial water and waste service, and in municipal water plants.—Allis-Chalmers Mfg. Co.

Composite Anode for Cathodic Protection

412

A new form of anode for cathodic protection systems using impressed current is available.

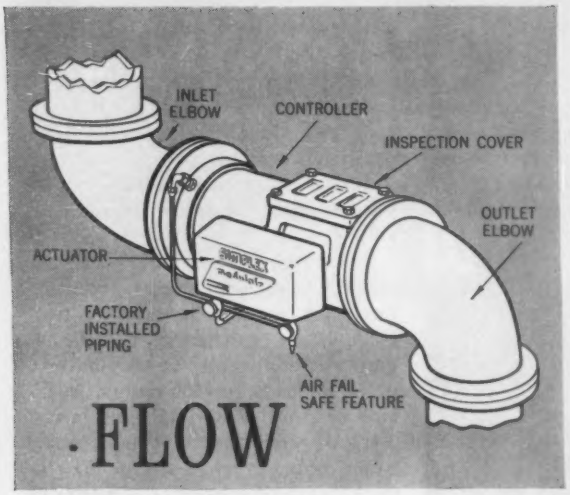
The device is a composite conductor which combines the high current capacity of copper, the anodic-passive properties of tantalum, and the non-sacrificial qualities of platinum. This new anode is available in a size equivalent to the No. 10 copper wire conductor.—Electro Rust Proofing Corp., Div. of Wallace and Tiernan Inc.

Size Gauge for O-Rings

413

A visual O-Ring Size Gauge for checking I.D. and cross section of O-Rings without manual or mechani-

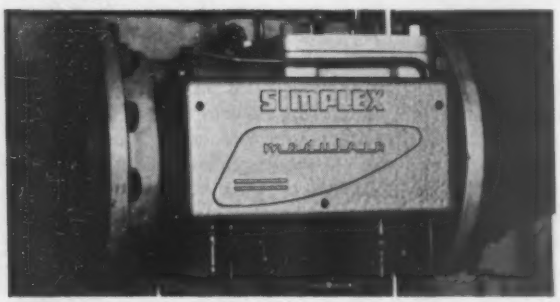
CONTINUED ON PAGE 86A



How to control it economically with this simple, modern "box on a pipe."

This is the Modulair Type "P" rate-of-flow controller, for your filter effluent piping.

You install it almost as easily as a piece of pipe, and its design is so utterly simple that you have almost no maintenance cost.



Note how Modulair "P" flow controller requires very little space in filter effluent line.

In fact, the minute you put this venturi-actuated, fully pneumatic controller to work, you get these new savings:

1. No valve operator
2. No water supply
3. No hydraulic valves
4. No drive gears and linkage
5. No "spaghetti" of complicated piping
6. No pilot valve or valve shaft
7. No leaky packing gland
8. No floor drain
9. Almost no maintenance

You save space, too, because the "P" controller has the shortest laying length of any, in addition to being entirely preassembled, with all working parts enclosed.

Send for our Bulletin 951, for details on space and cost savings of the "P" controller. Compare them with your present method of flow control. No obligation.

SIMPLEX
VALVE AND METER COMPANY
a division of PFAUDLER PERMUTIT INC.
Lancaster, Pennsylvania

Meetings

WHAT WHEN WHERE

1961

APRIL							MAY							JUNE						
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30																				

Apr. 17-18—Ann Arbor, Mich. (*Rackham Bldg.*) FOURTH CONF. ON GREAT LAKES RESEARCH. Sponsored by Great Lakes Research Div. of the Univ. of Michigan's Institute of Science and Technology. Gen. Chairman, Dr. Charles F. Powers, Great Lakes Research Div., 1119 Natural Science Bldg., Ann Arbor, Mich.

Apr. 19-21—Lincoln, Nebraska (*Cornhuskers Hotel*) NEBRASKA SECTION A.W.W.A. Secy., Joseph J. Rossbach, Metropolitan Utilities, 18th & Harney Sts., Omaha.

Apr. 20-22—Chandler, Arizona (*San Marcus Hotel*) ARIZONA SECTION A.W.W.A. Secy., A. D. Cox, Jr., Secy. & Comptroller, Arizona Water Co., Box 5347, Phoenix.

Apr. 20-22—Chandler, Arizona (*San Marcus Hotel*) ARIZONA SEWAGE & WATER WORKS ASSN. Secy., A. D. Cox, 2612 N. 16th St., Phoenix, Ariz.

Apr. 23-26—Greenville, South Carolina (*Pointsett Hotel*) SOUTHERN SECTION A.W.W.A. Secy., N. M. deJarnette, 96 Popular St., N. W. Atlanta, Ga.

Apr. 26-29—Victoria, B. C. (*Empress Hotel*) PACIFIC NORTHWEST SECTION A.W.W.A. Secy., Fred D. Jones, W. 2108 Maxwell Ave., Spokane, Wash.

Apr. 26-29—Santa Monica, Calif. (*Hotel Miramar*) CALIF. SEWAGE & INDUSTRIAL WASTES ASSN. Secy., Alfred D. Leipzig, 1200 Vista Del Mar, Venic, Calif.

May 2-4—Lafayette, Ind. (*Purdue University*) 16th PURDUE INDUSTRIAL WASTE CONF. Write: Prof. D. E. Bloodgood, School of Civil Engineering, Purdue University, Lafayette, Ind.

May 5—Harrisburg, Pa. (*Penn Harris Hotel*) NINTH ANNUAL PA. CLEAN STREAMS AND CLEAN AIR CONF.

May 8-19—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*) Training course: "Organic Industrial Wastes Characterization." Write. Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office.

May 9—Old Point Comfort, Virginia (*Hotel Chamberlain*) VIRGINIA INDUSTRIAL WASTES & SEWAGE WORKS ASSN. Secy., Orval J. Hand, Hercules Powder Co., Hopewell, Va.

May 22-24—Ocean City, Md. (*Commander Hotel*) MARYLAND-DELAWARE WATER & SEWAGE ASSN. Secy., W. M. Bingley, State Dept. of Health, 301 W. Preston St., Baltimore 1, Md.

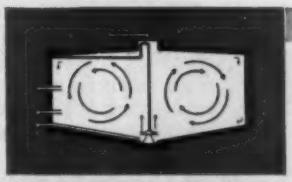
CONTINUED ON PAGE 84A

"from Chicago"

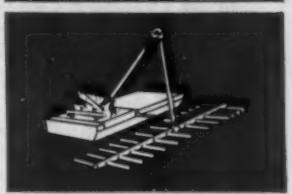
LOWER COST—MORE EFFECTIVE MUNICIPAL SEWAGE TREATMENT FOR THE 1960'S

Through a Continuous Program of Research and Development Chicago Pump Increases the Value of Your Public Works Dollar

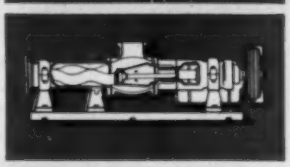
C.R.P.* ACCELERATED SLUDGE DIGESTION SYSTEM — An available means for increasing digester performance through continuous mixing.
Bulletin 145



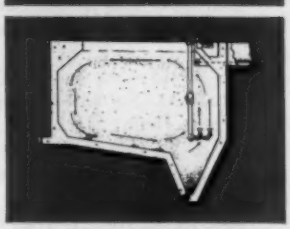
SWING DIFFUSER* AERATION EQUIPMENT — Assures dependable, continuous aeration with highest oxygenation.
Bulletin 175-A



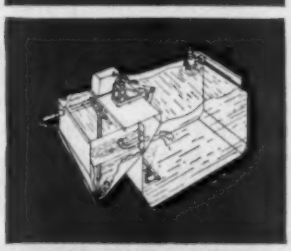
SCRU-FLO* POSITIVE DISPLACEMENT SLUDGE PUMP— Screw conveyor clog-proof sludge pumping.
Bulletin 191



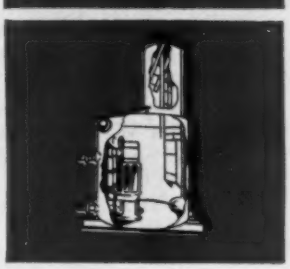
AER-DEGRITTER* GRIT REMOVAL SYSTEM — For controlled washing, transporting and concentrating grit.



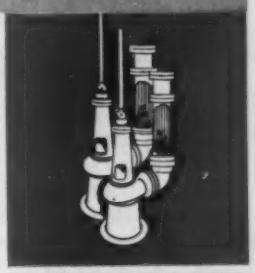
RATED AERATION* PACKAGED SEWAGE TREATMENT— For odor free, nuisance free, low cost, high treatment.
Bulletin 135-A



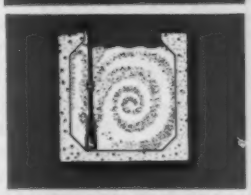
UT* PACKAGED UNDERGROUND LIFT STATION— Fully automatic pumping, factory fabricated and assembled.
Bulletin 121



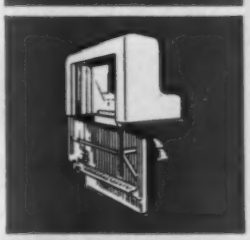
FLUSH-KLEEN® CLOG-PROOF SEWAGE PUMPS — With by-pass fitting for greater inflow capacity and flo-thru strainer for greater solids loading.
Bulletin 122-D



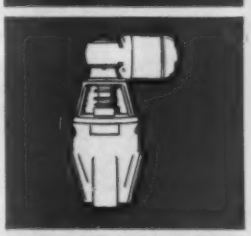
HYDROSHEAR* AIR DIFFUSION SYSTEM — Clog-proof, highest oxygenation and circulation at lowest air pumpage and power use
Buletin 178



BARMINUTOR* SCREENING AND COMMINUTING MACHINE — Continuous and automatic communition in rectangular channels.
Bulletin 186-B



NEW 4R COMMINUTOR TWO-WAY 4" CUTTING MACHINE — Increased cutting capacity with longer cutter life.



CHICAGO COMMINUTOR SCREENING AND COMMINUTING MACHINE—The original comminutor developed by Chicago Pump.
Bulletin 185-D

*TRADE MARK

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION
HYDRODYNAMICS DIVISION

CHICAGO PUMP

622 DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

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MEETINGS

CONTINUED FROM PAGE 82A

May 22-26—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*) Training course: "Inorganic Industrial Wastes Characterization." Write: Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office.

May 25-26—Pullman, Wash. (*Washington State University*) 10th PACIFIC NORTHWEST INDUSTRIAL WASTE CONF.

May 31—East Lansing, Michigan (*Michigan State University*) MICHIGAN SEWAGE & INDUSTRIAL WASTES ASSN. Secy., D. M. Pierce, Mich. Dept. of Health, Room 311, Admin. Bldg., Lansing 4, Mich.

May 31-June 2—East Lansing, Michigan (*Michigan State University*) MICHIGAN SEWAGE & INDUSTRIAL WASTES ASSOC. Secy., D. M. Pierce, Mich. Dept. of Health, Room 311, Admin. Bldg., Lansing 4, Mich.

June 1-3—Windsor, Ont. (*Prince Edward Hotel*) CANADIAN SECTION A.W.W.A. Secy., A. E. Berry, 72 Greenville St., Toronto, Ont.

June 4-9—Detroit, Mich. (*Cobo Hall*) A.W.W.A. ANNUAL CONFERENCE. Secy., R. J. Faust, 2 Park Ave., New York, N. Y.

June 5-7—Tuscaloosa, Alabama (*University of Alabama*) ALABAMA WATER & SEWAGE ASSN. Secy., E. J. Finnell, Jr., Univ. of Alabama, University, Ala.

June 5-7—Pullman, Wash. (*Washington State University*) 7th SEWAGE WORKS SCHOOL.

June 6-8—Morgantown, West Virginia (*West Va. University School of Mines*) SIXTH ANNUAL APPALACHIAN UNDERGROUND CORROSION SHORT COURSE. Write: Mr. John H. Alm, Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.

June 7-9— Springfield, Ill. (*Leland Hotel*) CENTRAL STATES SEWAGE & INDUSTRIAL WASTES ASSN. Secy., Scott E. Linsley, 2400 Childs Rd., St. Paul 6, Minn.

June 7-9—Okoboji, Iowa (*The New Inn*) IOWA SEWAGE & INDUSTRIAL WASTES ASSN. Secy., L. F. Skorczeski, 207 S. 15th Ave., Marshalltown, Iowa.

June 11-15—New York, N. Y. (*Hotel Commodore*) 54th ANNUAL MEETING AIR POLLUTION CONTROL ASSOCIATION.

June 12-16—New Brunswick, N. J. (*Rutgers University*) Short Course: Analysis of Water and Sewage. Contact Dean, College of Engineering, Rutgers, The State University, New Brunswick, New Jersey.

June 19-30—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*) Training course: "Aquatic Biology for Engineers." Write: Chief, Training Program, Robert A. Taft Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office.

June 20-22—Wernerville, Pa. (*Galen Hall Hotel*) PA. SECTION A.W.W.A. Secy., L. S. Morgan, 413 National Bldg., Greensburg.

June 20-23—Brighton, England. Annual Conference—The Institute of Sewage Purification.

Sept. 11-13—Louisville, Kentucky (*Brown Hotel*) KENTUCKY-TENNESSEE SECTION A.W.W.A. Secy., Harold F. Mount, Preston Street Road Water Dist. No. 1, 5400 Preston Highway, Louisville, Ky.

Sept. 12-Oct. 5—New Brunswick, N. J. (*Rutgers University*) Short Course: Water Works and Filter Plant Operation. Contact Dean, College of Engineering, Rutgers, the State University, New Brunswick, N. J.

Sept. 13-15—Saranac Lake, N. Y. (*Saranac Inn*) N.Y. SECTION A.W.W.A. Secy., Kimball Blanchard, Neptune Meter Co., 2222 Jackson Ave., Long Island City 1.

Sept. 13-15—St. Paul, Minn. (*Hotel Lowry*) NORTH CENTRAL SECTION A.W.W.A. Secy., Carl A. Flack, Water Dept., 216 City Hall, St. Paul 2, Minn.

Sept. 20-22—Rapid City, South Dakota (*Sheraton-Johnson Hotel*) JOINT MEETING SO. DAK. WATER & SEWAGE WORKS CONF., SO. DAK. SECTION A.W.W.A. and SO. DAK. WATER POLLUTION CONTROL ASSN. Secy., Don C. Kalda, So. Dak. Water and Sewage Works Conf., Div. of San Engrg., State Board of Health, Pierre, So. Dak.

Sept. 24-28—Poland Spring, Maine (*Poland Spring House*) NEW ENGLAND WATER WORKS ASSOCIATION

Sept. 27-29—Milwaukee, Wis. WISCONSIN SECTION A.W.W.A. Fortieth Annual Conf. Secy., Harry Breimeister, 507 Municipal Bldg., 841 N. Broadway, Milwaukee 2, Wis.

Oct. 1-3—Springfield, Missouri (*Kentwood Arms Hotel*) MISSOURI SECTION A.W.W.A. Secy., Warren A. Kramer, Chief, Water Supply, Div. of Health, State Office Bldg., Jefferson City.

Oct. 1-3—Springfield, Missouri (*Kentwood Arms Hotel*) MISSOURI WATER POLLUTION CONTROL ASSN. Secy., Jack K. Smith, Old Post Office Bldg., 112 W. High, Jefferson City, Mo.

Oct. 2-4—Taos, New Mexico. ROCKY MOUNTAIN SECTION A.W.W.A. Secy., H. F. Kepner, 550 Alcott, Denver 4, Colorado.

Oct. 17-Nov. 9—New Brunswick, N. J. (*Rutgers University*) Short Course: Sewage Disposal and Plant Operation. Contact Dean, College of Engineering, Rutgers, The State University, New Brunswick, N. J.

Synchro-Start's new protective engine controls have been designed, for the starting and stopping of engines from remote pilot devices, such as pressure switches, float switches, power failure relays, etc., and are completely automatic in operation. These dependable controls are encased in a steel, dust proof cabinet, and now feature enclosed PLUG-IN RELAYS as well as OVERLOAD BREAKERS. The plug-in relays simplify what little field maintenance that may have been required in older models, while the overload breakers eliminate the necessity of replacing fuses.

In designing this unit we have used the same high quality materials and workmanship that our customers have come to expect throughout Synchro-Start's 27 years of manufacturing engine controls.

ON TAP...

unlimited supply source for

HYDROFLUOSILICIC ACID

for lower cost, greater safety, assured supply!

- Compared to solid fluoride salts, IMC liquid hydrofluosilicic acid ships at *low* tankcar rates, requires less storage space, less handling.
- Eliminates extensive feed and dust control equipment... hoppers, agitators, dissolving tanks.
- Pumps directly into conduits. No health hazard of fluoride dust or need for special protective equipment.
- IMC is the *largest domestic producer* of phosphate rock — from which hydrofluosilicic acid is recovered. You're assured of dependable supply now and for years to come! For more facts, write direct.

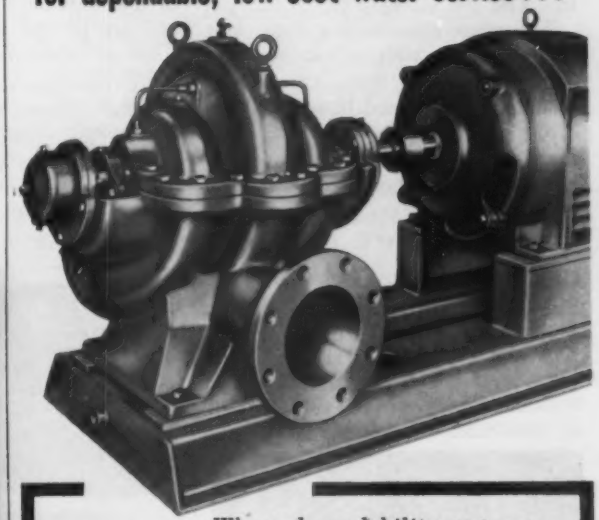
IC-6-01

INDUSTRIAL CHEMICALS DEPARTMENT
INTERNATIONAL MINERALS & CHEMICAL CORPORATION
Administrative Center: Skokie, Illinois

IMC

WEINMAN PUMPS

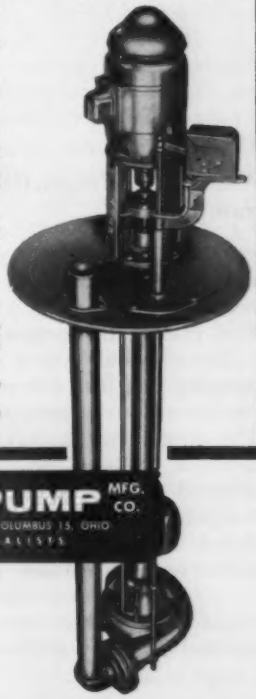
for dependable, low-cost water service...



Where dependability and performance count most — at critical pumping stages of water movement — you'll find Weinman Pumps. There's good reason for it, too. Weinman Split-Case Centrifugal Pumps are precision built to function continuously at top efficiency, with little or no maintenance. The horizontally split casing speeds routine maintenance and increases the "in-service" time of Weinman Pumps. Rotating parts are quickly inspected and easily removed or replaced without disturbing connections or driver. And, the rugged construction of Weinman Pumps stands up under the grueling punishment of 'round-the-clock operation. Municipal engineers and taxpayers alike benefit from the real economy of Weinman's dependable year-in, year-out trouble-free on-line service.

And, you get the same uninterrupted, dependable service from Weinman's outstanding line of Sewage Ejectors for the swift handling of liquids of varying viscosities carrying all types of foreign matter in suspension.

Write today for full information on all Weinman Centrifugal Pumps and for the competent, on-the-job assistance of your local Weinman Specialist, check the Yellow Pages.



THE WEINMAN PUMP MFG. CO.
290 SPRUCE STREET · COLUMBUS 15, OHIO
CENTRIFUGAL SPECIALISTS
MEMBER

Equipment News

CONTINUED FROM PAGE 81A

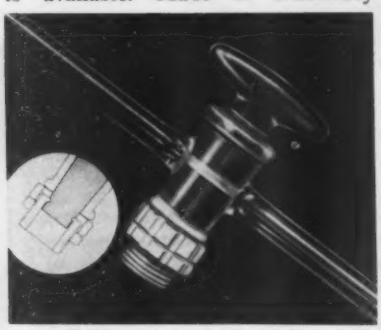
cal measuring has been recently introduced.

The gauge consists of a single unit cone and base with adjustable cross section measuring strip. The cone is mounted on a slotted base. The I.D. of the O-Ring is measured by placing the O-Ring on the cone, while the cross section is measured with slots in the base.—Parker Seal Co., Div., Parker-Hannifin Corp.

Glass Stopcock Lock for Pressure Applications

414

A glass stopcock for pressure applications which combines freedom of rotation with positive locking action is available. Made of chemically



inert Teflon and Marlex "50", it is designed for use with standard taper glass stopcocks for practically all laboratory reagents and will withstand complete autoclaving.

It is available in five sizes and may be used to convert standard taper glass stopcocks to pressure uses.—Fischer & Porter Co., Glass Products Div.

Automatic Proportional Sampler

415

A new automatic proportional sampler for measuring waste, process or stream flow has a slow speed fluid passing the sample point.

The new unit has a slow speed pumping unit that delivers a sample continuously to a plastic splitter box. The splitter box is part of the instrument housing which can be mounted above a sample bottle or a refrigerator if samples are to be chilled. The unit takes samples at the splitter box automatically proportional to flow utilizing signals transmitted by the flow meter. Sample size and frequency is adjustable over a range of 2000 to 1.

Housings are of constructed plastic and aluminum to resist corrosion and are purged with air to prevent corrosion of electrical parts.

By continuously sampling the stream, sediment build-up is negligible. By using the splitter box, small samples may be obtained which accurately represent the condition of fluid passing the sample point.—Plasti-Fab

Gas Turbine Engines

416

A 400 hp gas turbine engine has been added to the line of internal combustion engines for heavy duty industrial service. The new engine is a free shaft unit which incorporates a centrifugal compressor, annular combustor, two-stage turbine section and integral speed reducing gear case. It has high torque characteristics for truck and off-the-road vehicle applications, but can be connected to a fixed shaft version for alternator drive and other constant speed ap-

plications.

Simplicity of design and the use of sleeve bearings throughout, including speed shaft bearings, provide for a full power period of 20,000 hours between overhauls. Design, assembly and testing was conducted in collaboration with Williams Research Corporation at that company's laboratories.—Waukesha Motor Co.

Automatic Water Analyzer

417

A new instrument that provides continuous on-stream analysis of water; the Chemonitor, duplicates continuously and automatically the principles of colorimetric analysis thus determining and recording the amount of a specific component in water. A sample is piped into the instrument and mixed with reagents. When silica is present, the sample turns blue. The intensity of the color is then measured by the colorimeter and the measurement recorded on a recorder. When desired, the recorder operates an upper-limit switch that in turn actuates an alarm system.

In the zero to 300 ppb silica range, the unit permits detection of concentrations as low as 5 ppb with plus or minus 2 ppb accuracy.

Some typical applications of the instrument are analysis of boiled water, condensate and effluents from demineralizers, water softeners, and waste disposal treatment plants.

The analyzer can be set up to conduct single or multiple point analysis. Multiple point analysis is achieved by installing a mechanical timer and solenoid actuated valves on additional sample lines. The unit then can analyze as many as four points as frequently as desired.—Hagan Chemicals and Controls, Inc.

TO
ELIMINATE
TASTES AND ODORS
IRON AND
MANGANESE

use your present equipment and

low-cost Carox* Potassium Permanganate

Oxidize away those two difficult water problems: *tastes and odors;* stain-causing *iron and manganese*. With CAROX Potassium Permanganate and your existing equipment, you can readily supply quality water. CAROX water treatment usually costs far less than other prevalent techniques for eliminating these problems.

Potassium Permanganate can be used effectively in large or small water treatment systems. By oxidation and adsorption it removes musty, earthy, woody, moldy, swampy, grassy, and fishy tastes and odors; destroys phenols, chlorophenols, acrylates, hydrogen sulphide, mercaptans, organic herbicides, fungicides, and insecticides. It rapidly oxidizes soluble iron and manganese which are then removed by filtration and/or sedimentation.

CAROX is easy to handle, non-corrosive, and requires minimum storage space. It is an effective biocide and provides a coagulant-aid, minimizing quantity requirements on other chemicals.

If you'd like further information about using CAROX for quality water, write Carus Chemical Company, Inc., 1377 Eighth Street, LaSalle, Illinois, or phone CA 3-1500.

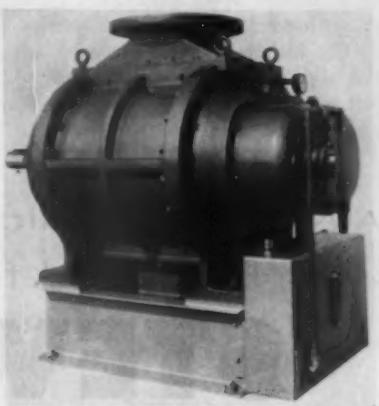
*TRADE MARK

CHEMICAL COMPANY, INC.

Heavy Duty Rotary Blowers

418

One-piece shafts, slip-fitted through impellers and bolted to them at the gear end, are featured on the new "Series 32" lobe-type rotary positive blowers and gas pumps recently introduced by the company.



This advanced design allows an increase in the diameter of the shaft in the critical area between impeller and gears without the loss of impeller strength caused by an enlarged bore. Also avoided is the use of the drive impeller to transmit power, which tends to deflect the impeller. A further advantage of a shaft larger at the gear end is the reduction of torsional deflection of shaft between timing gears and impellers, increasing pressure and horsepower ratings.

These new high performance units are designed to handle from 800 to 20,000 cfm at pressures from 2 to 10 psi continuous (12 psi intermit-use on all heavy duty systems which tent). They are recommended for have high volume air requirements. —Sutorbilt Corp.

NEWS OF SUPPLIERS

Multiplex to Celebrate Its 50th Anniversary

Multiplex Manufacturing Co., Berwick, Pa., manufacturers of Crispin Air Valves and Multi-Cold Condensing Units, celebrates its Golden Anniversary this year. The company, founded by C. G. Crispin, was incorporated on April 17, 1911. Today, Ben E. Crispin and Fred E. Crispin, sons of the founder, direct the activities of the company as President and Vice President respectively.

Crispin Air Valves are used primarily by the water and sewage, process, and hydro-electric industries to control air in lines carrying liquids. Air and Vacuum, Pressure, Negative Pressure, Universal, and Combination Air Valves are important products in the line. Special stainless steel valves for corrosive applications, midget valves for venting hot water systems, sewer, turbine, sewer check valves and slip joints are typical products that were developed by Multiplex to meet specific in-service requirements.

Henebry Named Director of F-M Water Division

John P. Henebry has been appointed to the newly created position of director of the Water Division of Fairbanks, Morse & Co., which manufactures and will market machines for desalting sea water.

Henebry was the founder and president of Skymotive, Inc., and airline service company at O'Hare International Airport, Chicago. He is currently a director of Eppi Precision Products, Inc., and of Great Lakes Dredge and Dock Co.

Roberts Filter Announces Two Executive's Deaths

Roberts Filter Manufacturing Co., Darby, Pa., regretfully announces the recent deaths of two of its executive personnel.

Mrs. Jesse W. Roberts (nee Douglas), Secretary and Director of the company died January 10, at Presbyterian Hospital in Philadelphia. Mrs. Roberts is the widow of Mr. Jesse W. Roberts, former president of the company.

Mr. Lloyd P. Carman, Purchasing Agent for the company passed away January 19. He had been associated with Roberts Filter for 37 years.

Layne Forms Organization for Water Progress

Layne Associates, a new organization, headquartered in Memphis, Tenn. was recently formed to promote progress in the development and conservation of water supplies and to provide technical information through research in the field of water.

Announcement of the formation of this group was made by John M. Proos, executive secretary of the organization. Mr. Proos is also Chair-

CONTINUED ON PAGE 90A

ACCURATE GRAPHIC AND VISUAL REGISTRATION

of liquid flow with

STEVENS

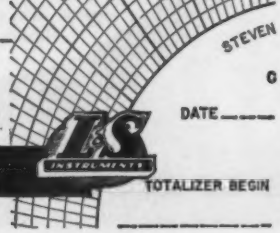
RECORDER TYPE B-FT

Recording, indicating and totalizing meter for measuring sewage or other flows over Parshall flumes and weirs. This instrument has interchangeable flow cams and flow conversion gears... an important factor to consider for sewage treatment plants in rapidly growing communities. With a simple change of cams and gears the Type B-FT Recorder can operate with a different size flume or accommodate a greater range of flow than that for which it was originally purchased. The change does not require factory service. Similarly, change from weekly to daily time scale, or vice versa, is accomplished by merely repositioning one gear — no new parts to buy.

This recorder can be direct float operated or remotely controlled and is available for wall or switchboard mounting, or with cabinet for mounting out of doors directly over the float well. Request BULLETIN 25 for complete details.

STEVENS HYDROGRAPHIC DATA BOOK

Invaluable for your reference file. Contains technical data on recorder installations, plus a wealth of hydraulic and conversion tables. $1 copy. (No COD's)



LEUPOLD & STEVENS INSTRUMENTS, INC.

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Specialists in hydrologic instruments for over half a century.

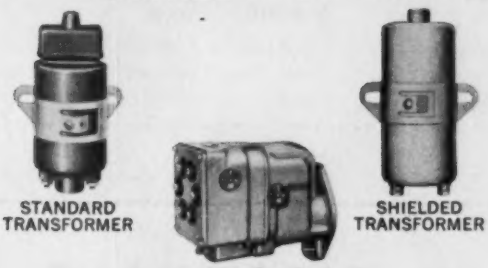
IMPROVE ENGINE DEPENDABILITY!

CUT MAINTENANCE COSTS!

NEW FAIRBANKS-MORSE

LOW TENSION IGNITION

...FOR GAS OR GASOLINE ENGINES



STANDARD TRANSFORMER

SHIELDED TRANSFORMER

TYPE FM-LTR
LOW TENSION MAGNETO

Best on the market because

- Increases engine life!
- Cuts maintenance and operating costs
- Simplified construction
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- Offered in standard and heavy duty models
- Offered with semi-low tension adaptation

This new F-M development gives a positive intense spark. Ozone and high corona discharge do not occur . . . eliminating "green corrosion"; promotes more complete combustion . . . requires far less engine maintenance, fewer spares.

For further details, write: **R. D. Hisey; Magneto and Engine Accessories Division; Fairbanks, Morse & Co.; Beloit, Wisconsin.**

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

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EXTRA STRONG . . .
BETTER LOOKING . . .
LIGHTER WEIGHT!

Exclusive swaging and forming process prevents cross bars from turning, twisting, coming loose or falling out . . . provides greater strength and rigidity than gratings using obsolete methods of joining bars. Only Gary Galok Aluminum Gratings offer all these advantages:

High strength to weight ratio. Minimum deflection . . . easier to install.

Non-rusting and corrosion resistant. Ideal where chemical conditions prevail.

Can be used for decorative purposes, sun-shades, grilles, etc. Can be anodized in sunfast colors to blend with surroundings.

Available with serrated or plain bars—in all sizes to meet practically every requirement.

*Patent Pending

Write for Bulletin
Dept. D-18, E. Seventh Ave., Gary, Indiana

ROCKWELL-STANDARD CORPORATION

Grating Division, Gary, Indiana

NEWS of Suppliers

CONTINUED FROM PAGE 88A

man of the Board of Directors of Layne & Bowler Inc., Memphis, manufacturers of Layne Vertical Turbine Pumps.

Other newly appointed officials include P. O. Bourgeois, chairman, International Water Supply Ltd., Montreal, Quebec, and Roy D. Woboril, vice chairman, Layne-Northwest Company, Milwaukee, Wis.

Layne Associates is composed of members from each of the thirteen Layne Associate well drilling firms, and Layne & Bowler Inc. The Research Division of Layne Associates is regarded as the largest research laboratory in the world devoted exclusively to water problems and the development of water supplies.

The new organization will seek newer and better methods, through research, for finding and treating ground water in ample supply and to keep up with the ever increasing demand for water required by industry, municipalities and agriculture.

F. P. MacDonald Elected President of Electro Rust-Proofing

Electro Rust-Proofing Corp., Bellville, N. J., announces the appointment of Frank P. Macdonald to the position of President. E. R. P. is a subsidiary of Wallace & Tiernan Inc., Belleville, N. J.

Mr. Macdonald joined E.R.P. in 1939. He and Leon P. Sudrabin, now Engineering Consultant for the company, are two of the pioneers in the principles of cathodic protection for corrosion control. Much of their research was conducted at the Dorr Company laboratories in Westport, Conn., in the early 1940's.

Wallace & Tiernan acquired the E.R.P. Corporation in 1946. Soon after, in March 1947, Mr. Macdonald was appointed sales manager of the new W&T subsidiary, and moved its operation to Belleville, N. J. Under his direction, E.R.P. expanded its activities until today it provides cathodic protection services for all submerged or underground metals—pipelines, water towers and storage tanks, ships' hulls and ballast tanks, etc.

Mr. Macdonald is a member of the AWWA, the National Association of Corrosion Engineers, and the American Petroleum Institute. He is also the author of numerous articles on corrosion which have appeared in trade journals.

Autocon Enlarges Assembly Area

Automatic Control Co., St. Paul, Minn., has disclosed that a second assembly area for production of its motor control center units has been

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put into use in the St. Paul, Minn., plant. John S. Williams, vice-president for sales and engineering, said the new area will increase production capacity of this department by over 100 per cent, and is essential to meet a current backlog of over $600,000 in orders for this type of equipment.

The new assembly area has a special "floating floor" construction, which is achieved by suspending the floor on steel beams and separating it from the regular floor on the plant's first-floor level. This is necessary to keep the floor absolutely level and free from stresses or strains, both for the installation of sensitive electronics equipment and for the elaborate testing required of each unit before it is checked out.

There also is an overhead lifting system, new heavy-duty wiring conduits, and special lead-in systems for testing equipment. The new assembly area is 60 feet long.

The motor control center, introduced just two years ago by the St. Paul firm, incorporates into a single "nerve center" all the timing, metering and protective devices and switches needed in a large plant—such as for water pressure control, air-conditioning, electrical load changes and other utility systems. By compacting all such mechanisms into one center the entire plant coninstallation; also the need for many different control panels, boxes and trol system can be pre-tested before gauges is eliminated.

Columbia-Southern Chemical Becomes Division of Pittsburgh Plate Glass

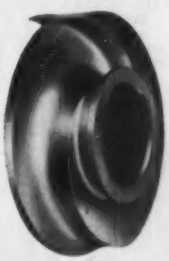
Columbia-Southern Chemical Corporation, a wholly-owned subsidiary, has become a division of Pittsburg Plate Glass Company, January 1, 1961, it was announced by David G. Hill, President of Pittsburg Plate Glass Company.

The new division will operate under the name of Pittsburg Plate Glass Company, Chemical Division. The principal officers of Columbia-Southern Chemical Corporation have been elected as officers of Pittsburgh Plate Glass Company, effective January 1, 1961. On that date, Joseph A. Neubauer will become Vice President and General Manager, Chemical Division, and Chris F. Bingham will become Vice President-Chemical Sales.

AURORA® CONTROLLED PERFORMANCE

NON-CLOG PUMPS

"The Pump with the single passage impeller"



MONO-VANE IMPELLER

- CAPACITIES TO 1000 G.P.M.
- HEADS TO 150 FT.
- BALANCED IMPELLER
- HORIZONTAL OR VERTICAL
- RUGGED CONSTRUCTION
- PROVEN DEPENDABILITY
- MINIMIZED WEAR
- FAST INSTALLATION
- EASY MAINTENANCE

The Mono-Vane impeller is in hydraulic and dynamic balance. It can be trimmed to suit various head and capacity requirements and still retain proper balance. The AURORA Non-Clog Pump is ideal for handling long stringy materials. Smooth, quiet operation is assured with the Mono-Vane impeller which is always in dynamic and hydraulic balance—even when trimmed to accommodate various head and capacity requirements. Single passage impeller design makes the AURORA Non-Clog pump ideal for handling long stringy materials. The discharge may be turned to any position to facilitate installation, service and maintenance. Clean-out cover is located in casing to provide easy service access.

Typical applications: elevating sewage, pumping sludge, handling heavy settleable solids, effluent, and other wastes and industrial by-products.

WRITE FOR BULLETIN 121 MV

AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
1020 LOUCKS STREET • AURORA • ILLINOIS

LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK

New Literature

AVAILABLE FREE

Electric Flow Meter

419

6-page technical bulletin No. 58-10A describes design features and principle of operation of the manufacturer's electrically operated remote reading flow meter.

These meters measure all types of fluid flow at line pressures up to 5000 psig. The meter consists of a restriction such as an orifice plate, in the flow line which creates a differential pressure proportional to the square of the velocity; an electric meter body that converts the differential pressure into a proportional electrical valve; and electrically operated reading instruments which indicate, permanently record and totalize flow. The bulletin includes drawings, photographs and instrument data charts—Republic Flow Meters Co., Subsidiary of Rockwell Mfg. Co.

PACIFIC
A TYPE FOR EVERY SERVICE
RUGGED — DEPENDABLE
NON-CLOG
SEWAGE PUMPS
DRY PIT - WET PIT
SUBMERSIBLE
HORIZONTAL
CHOICE OF IMPELLERS
NON-CLOG DRY PIT pump with double suction elbow and stand. Send for Bulletin 1850.5.
NON-CLOG WET PIT with cover. Single unit. Duplex models with alternating controls available. Send for Bulletin 1850.2.
PACIFIC NON-CLOG PUMP with motor, motor support bracket, suction elbow and stand. Send for Bulletin 1850.5.
HORIZONTAL NON-CLOG MODEL with flexible coupling. Send for Bulletin 1850.5.
Outstanding performance and long trouble-free service from every type. Pacific Non-Clog Sewage Pumps combine all desirable design features that assure efficient, economical and dependable operation and service.
Order now. ALL TYPES AVAILABLE FOR IMMEDIATE SHIPMENT.
SUBMERSIBLE NON-CLOG
A complete unit ready to install includes pump, motor, automatic controls and cable to control panel. Send for Bulletin 1850.5.
PACIFIC PUMPING CO.
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Manufacturers and Distributors of Pumps for Every Service
MAIN OFFICE AND FACTORY: 9301 San Leandro St., Oakland 3, Calif.
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Vertical Electric Motors

420

16-page Bulletin 219 presents the manufacturer's extensive line of solid and hollow-shaft vertical motors, 150 hp and up, in three basic types: squirrel cage induction, wound rotor and syncronous; and in 15 variations of design features.

The units are designed to meet any standard pumping requirement but can also be manufactured to order. Applications and design features of each type of motor are fully described and illustrated. The bulletin includes sample specifications and photographs of installations—Ideal Electric & Mfg. Co.

Plastic Pipe

421

38-page catalog (2nd edition) contains complete information on Byers PVC pipe. This book constitutes a useful manual on the many applications of polyvinyl chloride (PVC) pipe. Among the advantages discussed are: corrosion resistance, no contamination, low flow resistance, no rodent or termite attack, no environmental effects and ease of installation.

The catalog presents many tables with technical data on properties, dimensions, corrosion resistance ratings, recommended working pressures, head loss, etc. Instructions for installations are explained in detail—A. M. Byers Co.

Water Conditioning

422

4-page brochure illustrates and describes the manufacturer's equipment used in the hydrogen zeolite method of water conditioning. By this process, the metallic ions present in raw water are exchanged for hydrogen ions. This exchange effects simultaneous removal of all hardness and alkalinity from the water, producing an effluent of an acid character. The bulletin explains the three essential steps: exchange, neutralization and degasification.—Allis-Chalmers Mfg. Co.

Precipitator

423

20-page Bulletin 2204C illustrates and describes the operation, advantages and applications of the manufacturer's Precipitator. It operates on

the principle of precipitating floc by chemical feeding and agitation in mixing tank. Wide range of chemicals may be fed to meet specific water requirements.

Chief applications of the Precipitator are: water softening; removal of turbidity, color, taste and odor; reduction of alkalinity; removal of silica; and removal of iron and manganese.—The Permutit Co. Div., Pfaudler Permutit Inc.

Booster Pump

424

Bulletin B-703 illustrates and describes the new Hydro-Boost Pump designed to boost system pressure in the distributing line. The new pump provides a ready solution to adding a booster station on lines requiring additional pressure to serve newly developed areas. It is available in a complete range of sizes with capacities up to 8000 gpm, heads to 1000 ft, and motors up to 350 hp, and can be placed in lines ranging up to 16 in. in diameter. Bulletin includes a full sectional view of the pump and details of typical installations.—Peerless Pump, Hydrodynamics Div., Food Machinery and Chemical Corp.

Control Valves

425

8-page Catalog J170-1 contains complete engineering information on the manfuacturer's Sliding Gate and Plate Control Valves. Recommended for use on steam, water, air, oil, gas and chemicals, these Valves are available in sizes from ¼in. to 6 in.

Catalog gives applications, operating features, materials of construction, pressure and temperature limitations, photographs and cut-sections, flow curve, sizing charts and sample specifications. It also explains the operation of the patented Sliding Gate and Plate seats.—OPW-Jordan Corp.

Equipment Catalog

426

A listing of most major products of the Eimco Corporation is included in a new 18-page catalog. Included are the manufacturer's lines of tractors, loaders, mining equipment, process and filter equipment, etc.—The Eimco Corp.

Water, Sewage and Industrial Waste Treatment Equipment

427

Book 2617 presents the complete line of sanitary engineering equipment available from the manufacturer. In addition to drawings and photographs, the 20-page book contains useful information on proper methods of installing equipment in typical water, sewage and industrial waste treatment plants.—Chain Belt Co.

Packaged Pump Stations

428

6-page Bulletin PS-60R illustrates and describes the operating features of the manufacturer's duplex pump stations, available in pump capacities from 100 to 2000 gpm. On-the-job photographs show installation details. Drawings and sample specifications are also included.—Tex-Vit Supply Co.

Hydraulic Pipe Cutters

429

Catalog sheet illustrates and describes the manufacturer's line of hydraulic pipe cutters. Besides photographs, it includes a chart of capacities.

These cutters handle a wide range of pipe sizes in cast iron, asbestos cement, terra cotta, and corrosion-resistant pipe materials.—Wheeler Manufacturing Corp.

CONTINUED ON PAGE 94A

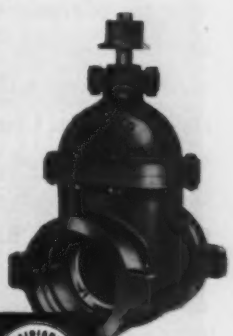
The Story of Water

Our Pilgrim forefathers and their American Indian neighbors conveyed water in buckets or stone jars from springs or creeks. As the population increased, industries were started. Villages became towns, towns became cities, small shops became great manufacturing plants. One of the basic things that made this possible was water.

For domestic use and for industrial use, over 17,000 water distribution systems have been built – dams, reservoirs, filtration plants, sewage systems. Instead of the Pilgrim's bucket and the Indian's stone jar, now we simply open a valve! Our modern cities could not exist, our vaunted American manufacturing industries could not operate without the valves which control their water supply and the fire hydrants which protect them from fire.

At M & H, we like to think that we have played an important part in the American Story of Water. For 34 years we have been making high quality, rugged and efficient valves and hydrants. Thousands of them are in service today in every State in the Union and in many foreign countries.

(No. 11 of a series)



M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF WALWORTH

New Literature

CONTINUED FROM PAGE 93A

Sewage Treatment System

430

8-page Bulletin 6650 explains in detail the use of the Hi-Cone Surface Aerator in aerobic digestion sewage treatment systems.

In addition to drawings and photographs, it presents a comprehensive selection graph which correlates oxygenation capacity and horsepower requirements of the two models most frequently used in sewage treatment plants for 50 homes and up, as well as municipal and medium-to-large commercial, institutional, and industrial installations.—Yeomans Brothers Co.

Pipe Cutter

431

4-page Catalog and Price List No. 41 on the manufacturer's heavy-duty pipe cutter. The tool is an all-purpose cutter, with interchangeable cutter wheels for all types of pipe: cast iron, steel, as well as vitreous clay pipe. Requiring only space enough to move the tool in a small part of a circle, it is well suited for use in trenches or other tight places.—Ellis & Ford Mfg. Co.

Pneumatic Master Control System

432

Bulletin 751 presents an outline and brief description of the Simplex Pneumatic Master Control System for water filtration plants. It includes an interesting flow diagram showing locations of vital equipment items for this system.—Simplex Valve and Meter Co.

Vertical Sewage Ejectors

433

8-page Bulletin 800 explains in detail the features of verticle non-clog sewage ejectors designed for positive handling of raw, unscreened sewage in commercial buildings and industrial plants.—The Weinman Pump Mfg. Co.

Cone Valves

434

6-page Bulletin No. 2 illustrates and describes the manufacturer's Cone Valves used broadly in water and sewage works for pump check, pressure regulating and critically located shut-off applications. Available in sizes 10 in. to 42 in. for working pressures of 150 and 250 psi.—Willamette Iron and Steel Co.

Water Storage Tanks

435

4-page brochure illustrates and describes design features and advantages of the new Cylindroid tank for large-capacity water storage. Brochure includes photographs of other types of large-capacity storage tanks offered by the manufacturer.—Graver Tank & Mfg. Co, Div., Union Tank Car Co.

Well Cleaning

436

The manufacturer's circular describes well-cleaning procedure using Industrial Chemical's Formula #117 "Well-Kleen". This product removes lime, iron, clay, silt and other encrustants from the screen itself and the strata around the screen. By re-

Tough break, but a cinch to sanitize—

with dry, convenient HTH chlorination. HTH releases effective, dependable chlorine to treat any emergency situation quickly . . . kill bacteria, algae and fungi fast. HTH sanitizes new pipe lines, protects wells and reservoirs, too. Comes in either free-flowing granular form or handy tablets . . . packed in easy-to-handle new 3-¾ lb. plastic containers, the popular 100-lb. drums, and in 35-lb. pails. Write for details today: **Olin Mathieson, Baltimore 3, Maryland.**

Here's to Health . . . **HTH**

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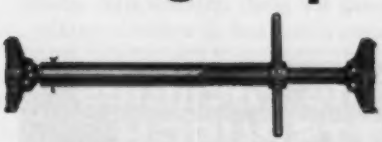
9312

CHEMICALS DIVISION Olin

safest way to dig deep



SIMPLEX
DROP-FORGED STEEL
TRENCH BRACES

- the only braces made of all drop-forged steel
- safest, strongest, most efficient and economical
- prevents cave-ins
- eliminates costly re-digging

Blunt safety-lever nut prevents damage, injuries. Ball-and-socket joints, plus lugs at each end, give quick set and tight grip at all angles. Nailing holes at both ends. Pipe sleeve adapts brace to any trench width. Overall closed lengths, with pipe, from 18" to 60", screw extensions from 7" to 10". Also available without pipe.

Get all facts, write for Catalog M-60

SIMPLEX
RE-MO-TROL UTIL-A-TOOL JACKS JENNY ROL-TOE

TEMPLETON, KENLY & CO.
2569 Gardner Road • Broadview, Illinois

moving these deposits and permitting more water to flow into the bottom of the well, the capacity can be increased. The chemical is not toxic and is not corrosive.—Industrial Chemicals, Inc.

Blowers

437

2-page summary bulletin explains the purposes and capacities of each series of the manufacturer's expanded line of rotary positive displacement blowers. Information includes: speed and pressure ratings, gear diameters, overall unit sizes, details of special features and directions for connecting to power sources. There are 3 series of small blowers and 3 series of large blowers.—Sutorbilt Corp.

Parshall Flume Has Corrosion-Resistant Properties

438

Bulletin 802 which describes its new polyester resin-bonded Parshall Flume. The corrosion and chemical resistant qualities of this one piece, complete length, integrally molded flume make it ideal for installation in sewage or industrial waste plants where accurate measurement is required. The flume is constructed with longitudinal as well as transverse resin-forcing struts giving it rigidity and strength so that it may be used unsupported if necessary. Molding techniques provide dimensional accuracy not encountered with concrete structures.

These flumes are available in sizes ranging from 3 in. up to and including 24 in. throat widths. One of the great advantages is the light weight of the unit which permits its easy handling.—Simplex Valve and Meter Co.

Floating Digester Cover

439

An 18-page informative brochure on the company's "Monodeck" digester tank floating cover gives complete information on the new trussless, single plate and pontoon floating cover, including detail design, basic principles of operation, specifications and performance advantages.—Infilco, Inc.

CONTINUED ON PAGE 96A

MORE THAN 2000 PRESTRESSED CONCRETE TANKS IN SERVICE

New 660,000 Gallon Stand Pipe
City of Wadsworth, Ohio

Consider these features
- Minimum maintenance
- 75% construction cost spent locally
- Owners seldom return to other types
- Longest service life of any tank
- Lowest overall cost to community

Send for Bulletin T-22

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28400 Clawiter Road, Hayward, Calif.
Tel.: LUcerne 1-4451

New Literature

CONTINUED FROM PAGE 95A

Concrete Coating for Underwater Pipelines

440

A brochure presents the salient details of Wate-Kote concrete coating for underwater pipelines. The primary purpose for this application is to provide the necessary additional weight to overcome both the buoyant force of the fluid backfill and the dynamic uplift due to bottom turbulance.

The publication includes on-the-job photographs of the material, a list of pipe displacements and weights, and graphs illustrating the properties of the materials when applied.—Rosson-Richards Processing Co.

Combination Sludge Clarifier and Thickener

441

Process Clair-Thickener sewage treatment units combine sludge thickening and primary or secondary clarification is described in a single tank, in a new illustrated 4-page bulletin newly released.

This treatment unit is built with a separate thickening compartment located at the tank bottom within the clarification section, the bulletin explains, for holding settled sludge 12 to 24 hours for thickening to maximum density. A blanket zone of oxidative liquids over the thickening compartment controls septicity during holding periods.

The bulletin points out how, in many sewage treatment plants the use of this multi-purpose, Clari-Thickener unit will eliminate the need for separate thickening and clairfication units.—Eimco Corp.

Automatic Tape Analyzer

442

A 4-page bulletin describes an automatic tape analyzer used for measuring trace quantities of insoluble solids in liquids.

The bulletin includes a photograph of the unit, an operational diagram, a list of specifications and a list of its various applications. Among these are for municipal water supplies, waste treatment, central stations and industrial power plants, wash systems and air pollution control.—Graver Water Conditioning Co., Div. of Union Tank Car Co.

Iron Valve Cylinder Operator

443

An 8-page catalog that describes the company's standardized iron valve cylinder operator that is available in 127 iron valve cylinder combinations or as a kit to power up presently installed Crane iron body valves.

The bulletin provides pictures and diagrams that illustrate how the operator is constructed and how it functions when installed. Tables are provided so that the user may conveniently select the proper operator for his particular needs. Another table presents ordering and dimensional data. Crane Co.

Spiral Weld Pipe Machines

444

A 43-page booklet describes in detail spiral weld pipe mills and ancillary pipe making and testing equipment for steel, stainless steel, aluminum, titium and all weldable metals.

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Although this complex machine was primarily designed for the on-the-job "instant" fabrication of pipe for gas transmission lines, its product finds applicability in the water and irrigation fields.

The literature is filled with pictures, diagrams, tables and construction data explaining not only how the pipe is made but how it has performed in use. Diameters of the pipe produced by the unit are from ½ in. to 20 ft.—Driam Corp.

Horizontal Split Case Pumps

445

An 8-page bulletin gives the pertinent data on its horizontal, split case pumps which are designed for water and clear liquid transfer in water treatment plants, and other applications.

Cutaway drawings, specification data, dimensional drawings and tables, and installation photographs are included. Also featured in the bulletin are composite charts that graphically relate head as measured in feet and U.S. gpm to pump size and speed in rpm; these charts help simplify pump selection.—American Well Works.

Rotary Source Water Strainer

446

An 8-page bulletin describes the construction and operation of their "Deptford" Rotary Water Strainer designed for the economical removal of seaweed, leaves and vegatable matter from water taken from natural sources.

Illustrations and diagrams show the construction of the strainer which is essentially a revolving perforated brass drum enclosed in a cast iron housing. Incoming water is delivered to the outside of the drum which revolves against a scraper to remove debris caught in the perforations, and the cleaned water is discharged through the end of the drum to the casing outlet. Installation requires a minimum of foundation work, and the unit embodies many features which facilitate erection and maintenance. Richardsons Westgarth, Inc.

Copper Sulfate for Root Control

447

An 8-page booklet provides the important details of using copper sulfate for protecting house drains flowing to septic tanks and absorption fields from tree roots.

The booklet discusses roots, the septic tank and the absorption field separately, and shows how the use of copper sulfate prevents drains from being clogged or broken by not penetration. Illustrations are provided.—Phelps Dodge Refining Corp.

Water, Sewage and Waste Treatment Catalog

448

A 20-page catalog of equipment for water, sewage and industrial waste treatment illustrates and describes, with specifications details, the construction for circular clarifiers up to 200 ft diameter, and rectangular clarifiers with crane type scraping mechanisms. Included also are illustrations and cross-section drawings of digesters and automatic backwash sand filters —Hardinge Co.

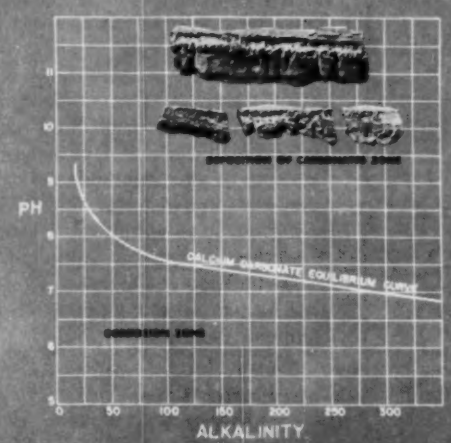
Dry Chemical Feeders

449

A 4-page folder containing technical data describes its dry chemical feeders designed for a wide range of

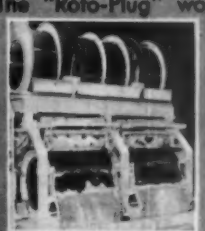
CONTINUED ON PAGE 98A

"ROTO-PLUG"* SLUDGE CONCENTRATOR
ELIMINATES COSTLY
FILTER MEDIA MAINTENANCE



The "Roto-Plug" Sludge Concentrator dewaters sewage sludge without the use of conditioning chemicals. This feature eliminates the costly problem of periodic acid washing of filter media to remove calcium carbonate deposits. Where chemicals are used to condition sludge it adjusts the pH of the sludge upward to pH 9 or higher and causes the formation of calcium carbonate. When referred to the carbonate equilibrium curve of water practice, the condition of the sludge is high in the "deposition of carbonate zone".

The "Roto-Plug" works with the sludge "as is" thereby eliminating the age-old problem of decreased production due to calcium carbonate blinding of filter media.



For full details about the economical "Roto-Plug" method of dewatering sewage sludge write for our four-page illustrated folder RP-100.

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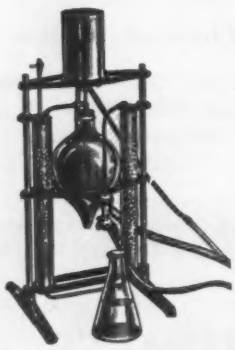

For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

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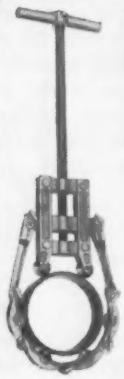

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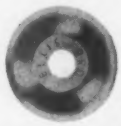

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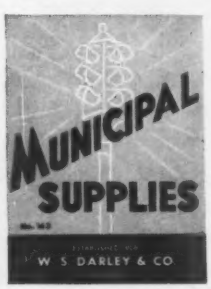

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NEW Literature

CONTINUED FROM PAGE 97A

range of water and industrial waste process applications.

The literature includes operating data, plans for installation with overhead storage hoppers for continuous feeding, and information on solution chambers that can be adapted to four types of installation under the feeder. —Permutit Co.

Factory-Built Sewage Plants

450

Latest catalog describing the company's most recent design in factory-built sewage treatment plants includes such useful information as dimensions, motor horsepower, design and construction.

The catalog was written with the consulting and municipal engineer primarily in mind. On-the-job photographs, tables, charts and diagrams illustrate the construction and operation of the units.—Schmieg Industries, Inc.

Pipe Detection

451

A 24-page illustrated booklet entitled, "Typical Pipe Detection Problems and Their Solution". The publication is intended to help pipeline contractors, water companies and municipalities locate underground pipelines.

With this "How To Do It" guide, pipe repair and installation crews can locate, trace, center or determine the depth of pipe, conduits and cables using the pipe detector and by following the steps outlines in the book. A section in the book explains in easily understandable language the basic theory of the pipe detector.—Computer Measurements Co.

Suburban Water Distribution Plan

452

A "photo story" sheet outlines the design and operation of a suburban water distribution complex using the company's equipment.

The complex is illustrated by an operation diagram that shows the

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location and interrelationships of its various units. A picture of one of the company's control units is included.—Automatic Control Co.

Water Hardness Tests

453

4-page bulletin HSP-903 deals with procedures, reagents and equipment for one-minute water hardness tests. It describes Hall Laboratories' adaptations of the Schwarzenbach titration method of testing for total hardness, calcium and magnesium.

The determinations are both rapid and accurate and are applicable to all waters containing hardness, including raw water, softened water and boiler feedwater. Sensitivity of the tests is about 1 ppm, expressed as calcium carbonate ($CaCO_3$) or less than 1 ppm calcium.—Hall Laboratories Div., Hagan Chemicals & Controls, Inc.

Water Control Equipment

454

Publication of new 212-page catalog presents a comprehensive coverage of the company's water control equipment.

Among the items described in the catalog are sluice gates, hoisting equipment, fabricated metal gates, fabricated wood gates, valves, regulators, racks, rakes and screens. In addition, the catalog includes engineering data and tables and a description of the company's manufacturing facilities.

The publication is liberally illustrated.—Rodney Hunt Machine Co.

Huge-Volume Water Pumps

455

A new bulletin describes the Hydro-Foil pumps designed to permit effective control and regulation of huge volumes of water. The pumps are especially suited for applications in dewatering, flood control and industrial water service and are capable of handling 220,000 gpm with lifts ranging from 2 to 60 feet.

Complete details of each pump type, with sectional views of the components, are presented in the bulletin. Other sections cover the types of available drives and installation pictures. A page of diagrammatic drawings illustrating typical pump station arrangements is also included. —Peerless Pump, Hydrodynamics Div., Food Machinery and Chemical Corp.

CONTINUED ON PAGE 100A

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NEW Literature

CONTINUED FROM PAGE 99A

For Control of Microscopic Organisms

456

A 43-page booklet thoroughly discusses the use of copper sulfate in the control of microscopic organisms. This is the seventh edition of this work which was primarily written for water works and sanitary engineers, and public health officials and instructors.

Accompanying and augmenting the text are various illustrations, including tables, photographs and diagrams. —Phelps Dodge Refining Corp.

Water Meters

457

4-page Bulletin DER-961 describes the design features and principle of operation of the Easy-Read Magnetic Drive Meter, which combines time-proven disc meter accuracy and dependability with the efficiency of magnetic drive. Besides tables of specifications, the bulletin includes drawings and photographs.—Badger Meter Manufacturing Co.

Cement-Mortar Lining Process

458

A 20-page bulletin provides the salient details of its process for the cement lining of pipelines ranging from 4 to 144 in. in diameter.

Not only is the process itself fully described, but the equipment used in the process is discussed and pictured. Technical aspects of the process are presented by means of tables, diagrams and graphs, and on-the-job photographs take the reader through successive stages of the pipe cleaning and lining operation.

Incidentally, Centriline has joined the growing number of company's that have adapted the television camera for underground pipeline repair use.—Centriline Corp.

Screen Strainers

459

Fully illustrated 4-page brochure, bulletin S-56 describes in detail the manufacturer's line of taper and basket type pump strainers and special large capacity strainers. It presents pictures of the types of strainers. Specifications and price list are included. —Strataflo Products, Inc.

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**Prepared by a Joint Committee of the Water Pollution Control Federation and the American Society of Civil Engineers, 1960.*

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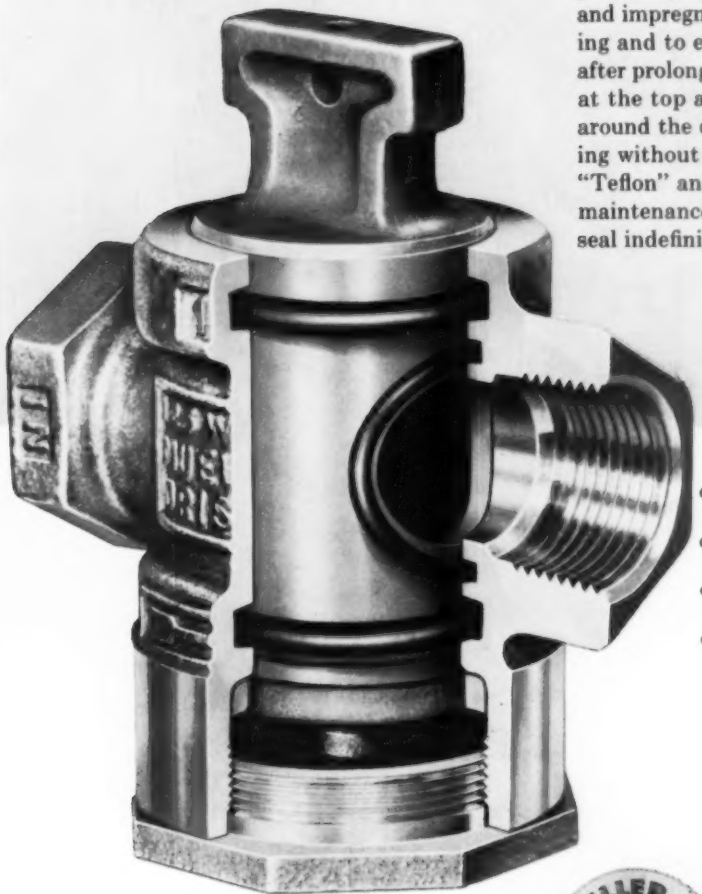

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